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SCIENCE AND TECHNOLOGY

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ADVANCED MATERIALS

GIGANTIC LITHIUM DEPOSIT DISCOVERED IN FRANCE

Paris LIBERATION in French 19 Feb 85 p 17

[Article by Jean-Francois Rouge]

[Text] Geologists suspect that a huge vein of lithium and other so-called "metals of the future" hide beneath the ground around Montlucon, in Allier. But their exploitation requires enormous investments, about which neither the government nor industrialists are very enthusiastic.

Echassieres (special correspondent)--There are those who already view this deposit in the Massif Central as one of France's great mining fortunes. A quasi-inexhaustible source of tin and all the rare strategic metals, indispensible for the alloys of the future demanded by the space or electronics industries: tungsten, lithium, tantalum, or beryllium.

For the time being, however, the small Echassieres quarry in Allier, near Montlucon, supplies only kaolin, that very pure white clay used in paper making or for porcelain. The dormant exploitation of this kaolin was bringing only losses to the two private owners of the quarry. Several months ago, BRGM (Bureau for Geologic and Mineral Research) bought it from them. For this government agency, kaolin is only a secondary objective, despite the fact that its Coframines subsidiary has invested 5 million francs to make it profitable. It is especially a matter of gaining a foothold at the site for a thorough, in depth examination, to learn exactly what is lurking under the kaolin. Enormous riches are suspected, but the investments necessary to bring them up are also fantastically high. The geologists can therefore afford no mistakes. Consequently, they fall back on fundamental research: they want to know everything about the formation conditions of the Echassieres deposit.

As part of "France's deep geology" program initiated by CNRS (National Center for Scientific Research), BRGM and several universities are carrying out a vertical deep drilling of the quarry (see LIBERATION of 26 October 1984). For 2 million francs they expect to scratch away at the granite to a depth of 1000 meters, a level which should be reached in a little more than one month. In addition to an accurate evaluation of existing interesting metals, one key

result might be the solution to one of the great enigmas of geology: the quasi-miraculous accumulation of ores at the top of some granitic domes. A theoretical problem which could have significant economic spinoffs throughout the world.

A Bubble Rising For Millions of Years

Very often, as at Echassieres, granite occurs as outcroppings in the shape of enormous domes. The phenomenon takes place when a "hot spot" appears at a depth of tens of kilometers, at the boundary between the earth's crust and mantle. This hot spot softens a piece of the crust; lighter as a result, the liquefied rock starts to rise to the surface like a drop of oil. It becomes a sort of gigantic hot bubble, foreshadowing the shape of the future granite dome. This is not a sudden uprising, as in the case of a volcanic eruption; it takes millions of years, interspersed with phases of rest. Consequently, instead of cooling down rapidly to produce a thick and homogeneous lava, the magma has time to crystallize very slowly in the form of granite.

In its progression, this granite multiplies its damage. It roasts the neighboring rock and vaporizes infiltrated water. And the geologists believe that it is indeed this pressurized water which plays an essential role in the formation of the metalliferous deposits. The steam washes out the most volatile elements: fluorides, chlorides, metals. The mineral wealth of this steam obviously depends largely on that of the granite and other rocks through which it passes, since the saturated steam seeps through all the fractures which it encounters. As soon as the temperature and pressure drop, the chemical elements begin to deposit themselves on the walls of the fault in a very precise order, thus forming metalliferous veins which can measure a few millimeters or several meters.

So much for the basic scenario, as it is now imagined to be probably correct. In fact, the ideal process is more complicated at Echassieres: three successive granite bubbles piled on top of each other, tens of million years apart. The last produced the Beauvoir granite, a completely white rock whose feldspar, decomposed by runoff water, left the famous kaolin at the surface. As an incredible stroke of luck, the three generations of granite were all metalliferous!

To be exact, no one has ever seen the first of these bubbles, the Bosse granite. Its existence is only suspected from the halo of ores it has projected on the surface, somewhat like one finds a dead star from the fossil light it is still sending us. Actually, one of the goals of the deep drilling is to attempt to verify this hypothesis.

Andre Lajoinie Supports French Lithium

Another world premiere expected from this attempt is the grand opening of "quantitative metallic deposit exploration." The Echassieres granite cupola has always been considered a texbook case: the zone involved is rather small (five kilometers in diameter at the surface) and well defined. The aim is to

attempt a comparison between the initial metal content of deep granite, and the fantastic ore concentration at the surface. The theory is that several tens of thousandth parts of metal are sufficient to yield a particularly rich ore deposit after steam cleaning. An attempt will be made to prove it in the field with chemical equations.

But at the surface, the politicians are stirring while the geologists sharpen their theories. The Allier representative happens to be Andre Lajoinie, the communist leader. He did not take long before asking for the establishment of a "lithium industry" in the name of the "produce French" slogan: "It is unthinkable," he stated last fall, "that the lithium-alloy aluminum sheets for Dassault or Aerospatiale, which Pechiney plans to fabricate at its Issoire plant not far from here, should use imported lithium, when we could be producing it in France."

But Pechiney, BRGM, and the government wonder whether it is worth it. Of course, the lithium reserves at Echassieres are valued at 300,000 tons of metal; a fantastic figure, when we know that the world lithium production (about 7000 tons per year) is strongly dominated by two American companies, and that France, which uses nearly 200 tons, imports 100 percent of its needs.

Except that one would first have to be able to profitably extract the lithium contained in the mica of the Echassieres granite. They are working on it, but the result is still uncertain (the Americans don't have this problem, they use another ore). Furthermore, does the world consumption expected in about ten years justify the creation of a whole industry? Lithium is a strange metal: although very soft and extremely light (it floats on water!), the addition of one percent to aluminum sheets reduces a plane's weight by 15 percent. It is also widely used in pharmaceuticals to treat manic-depressives, as well as in watchmaking and chemistry.

Same Profitability Questions for Tin

With very small differences, the terms of the problem are similar for tin, tantalum, tungsten, or beryllium: a definitely growing world consumption, France totally dependent on foreign supplies (generally American), and non-existent industries to be created from scratch, with the enormous investments they entail. All the profitability of this fragile edifice depends on the answer to this nightmarish question: what will the dollar be worth ten years from now, when French lithium or tin will eventually begin to flow on the world market?

It is easier to understand Pechiney's hesitation under these conditions. In the meantime, at Echassieres, a handful of miners continue to serenely gather their kaolin. This exploitation has been prospering for 200 years, and the exchange rate of the dollar has had no effect on it; the porcelain bidet at least, has never let France down!

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CSO: 3698/288

ADVANCED MATERIALS

BRIEFS

NETHERLANDS FUNDS MEMBRANE TECHNOLOGY--Wageningen, 16 February --- This year the Economic Affairs Ministry will be spending 7.47 million guilders on membrane technology. The money will be used for funding 17 projects via the so-called innovations directed research program. As a result of this membrane technology will become the second innovations directed research program, after biotechnology, in which a beginning is being made. In the course of the next 8 years a total of 26 million guilders will be dedicated to this. At the presentation made yesterday Prof C. A. Smolders, the chairman of the program's commission that selects the projects, mentioned three areas of application. In the industrial area thought can be given to gaseous separation. Thus, for example, carbonic acid and methane, which emerge as a compound during oil extraction operations, can be separated. Actually membranes are already being employed in environmental technology for the purification of water which percolates through refuse dumping sites. In the medical sector artificial kidneys represent another type of application. Nine of the projects have been awarded to T H of Twente, five to TNO, two to the Agricultural University of Wageningen and one to the Netherlands Institute for Dairy research. The world market for membranes is now being estimated at 700 million dollars. The United states has 75 percent of the market; Holland has 2 percent. According to experts in 15 years this will develop into a 2.4 billion dollar market. In Holland various small industries such as Wafilin, Setec and Najade are engaged in the production of membranes. As a subsidiary of Akzo, Enka Membrana is the largest European membrane producer in Europe. Large concerns such as Shell and Akzo are becoming increasingly interested, according to the interested experts. [Excerpts] [Rotterdam NRC HABDELSBLAD in Dutch 16 Feb 85 p 13] 7964

CSO: 3698/268

AEROSPACE

IGNITION, SEPARATION OF BOOSTERS, STAGES IN ARIANE 3

Munich FLUGREVUE in German Dec 84 p 27

[Article by Goetz Wange]

[Text] Ariane 3 fortified with two additional solid-fuel rockets has now passedits second verification test. The European booster rocket took off on November 10 from the launching pad in Kourou with the satellites SPACENET and MARECS-B2.

The engineers spoke of a routine event, but the managers could not hide their nervousness. Nothing less than two sensitive satellites were sitting in the payload tip in the second launch of Ariane 3: On the one hand, the communications satellite SPACENET-2, an order from the bitterly fought-over American market, on the other hand, MARECS-B2, a substitution satellite for that marine predecessor which had been lost on September 9, 1982 during the unsuccessful fifth start of the European booster rocket. A mistake which now was corrected because firing into the geostationary transfer orbit proceeded with extraordinary precision.

Takeoff took place according to schedule at 2:14 (MEZ), not by pushing a button but, as has long become routine, automatically, because, six minutes prior to the scheduled ignition moment the men at the takeoff control center in Kourou can no longer have a hand in the unrolling of events. Two computers monitor all parameters. There are far too many data which must be interrelated in seconds for man to still make the decisions.

About three and a half seconds after ignition of the first stage, the Ariane 3 with a height of 49 meters and a weight of 238 tons lifts from the launch pad. At first, hesitantly and only at half the speed of a one-hundred-yard runner. But then the two nine-meter solid fuel boosters typical for Ariane 3 do their task and help accelerate the rocket to its final speed of 36,000 kilometers per hour.

These two additional solid boosters - a development of the Italian SNIA BPD company - are the outwardly most remarkable characteristic of Version 3 as compared to the basic type. As a secondary packet to the first stage, the boosters weight 9.7 tons each and develop, respectively, 70 tons additional thrust. They can be ignited only 7.2 seconds after liftoff of the large rocket because they would otherwise damage holding devices at the launching pad.

In the first three missions of Ariane 3 - the next one is scheduled for late January or early February - built-in movie cameras monitor dropping of the two solid rockets. About 30 seconds after ignition, the boosters are burnt out and are separated at an altitude of 4.6 km from the first stage with springs. Not entirely riskfree for the takeoff facilities in Kourou because the empty shells hit ground at a distance of roughly 1 km from the center and may come so close with unfavorable winds that damages may occur.

With the enlarged double takeoff structure SYLDA 4400 the two satellites can be taken cost effectively on the road to their geostationary orbit above the equator.

The payload sheath (fairing) protecting the satellites against damage during takeoff - a development of the Swiss Contraves company - is to be dropped as soon as possible after separation of the first stage in order to save weight. However, since the satellites cannot withstand friction at the atmosphere without this fairing, the onboard computer measures the flow continuously. Only when the heat load has dropped to below 1,135 watt/m^2 - an indication of the existing residual atmosphere - the payload fairing is separated automatically.

At about 150 km altitude, four and one half minutes after takeoff, the second stage, built in the FRG under the auspices of MBB-ERNO, is separated.

The Ariane flight is observed from a total of four telemetry stations: Montagne des Peres (Guyana), Natal (Brazil), Ascension Island and Akakro (Ivory Coast). Here, the Ascension station - an island off the coast of West Africa - is of special importance because it observes the last phase of the third-stage flight and firing into the transfer orbit. The facility is part of the worldwide NASA net - the operator of the Ariane competitor Space Shuttle. Three communications satellites and the detour over Washington are necessary to transmit Ariane signals to the flight control center in Kourou.

About 18 minutes after takoff, the SPACENET-2 on top separates from the upper stage, then the SYLDA structure is dropped and the MARECS-B2 below it is freed. An additional three minutes later, also the last satellite is released.

TAKEOFF SEQUENCE

	Time(s)	Height(km)	Rel.Speed (m/s)
Liftoff from launching pad	3.4	-	-
Booster ignition	7.2	12 m	6.82
Booster drop	39.2	4.6	278.90
Stage separation 1/2	139.9	57.2	1,989.00
Stage separation 2/3	268.8	150.6	4,560.40
Propellant cutoff 3rd stage	991.5	208.8	9,750.70

The successful takeoff of SPACENET-2 and MARECS-B2 has further promoted the reputation of the European booster rocket Ariane as a reliable means of transportation. The commercial marketing company ARIANESPACE, in which the German astronautical companies MBB-ERNO, Dornier, MAN as well as three banks in the Federal Republic participate with a total of 19.6 percent, is thus given an additional impetus. At present, 30 satellite takeoffs are in the order books. A value of 2.3 billion marks.

Picture caption (P. 26 in original)
The camera as companion: At 4.6 kilometers altitude, a high-speed camera (50 pictures per second; 100 mm optic) films the separation of the additional solid fuel rockets used for the first time in the Ariane 3 version. The French Astronautics company Aerospatiale mounted the camera for this purpose on a platform at the tip of the small solid fuel boosters.

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CSO: 3698/173

BIOTECHNOLOGY

STUDY OF BIOTECH IN FRANCE SHOWS RESEARCH, FINANCE STATUS

Current Situation Overview

Paris BIOFUTUR in French Dec 84 pp 7-13

[Article by Jean Comar, Pierre Darbon and Jacques Robin: "Facing the Biotechnology Challenge: Revival and Opening"]

[Text] France knows it must not "flunk" biotechnologies. No one questions any longer the fact that today's research is perfecting the tools that will create products and processes without which entire facets of the French economy would be in jeopardy tomorrow. Thus, researchers and manufacturers were pleased to see that, in 1982, biotechnologies were confirmed as a "national priority" and that a "mobilization program" was created for the "rapid development of biotechnologies."

To mobilize... they chose the right word. For, although France possessed assets to excel in biotechnology, it also had scientific and structural handicaps and, we might add, handicaps resulting from its character:

- in certain scientific disciplines that are essential for biotechnologies, the French had been "marking time" for several decades: in microbiology for instance. In fermentation engineering, France did not rank among the first;

- the French domestic market is smaller than, for instance, the U.S. market, and the gap is especially large in advanced technologies;

- exporting and marketing did not come as naturally as it does, for instance, to the Japanese; now, to have the courage to invest in long-term venture technologies whose fruits, promising as they may be, cannot be harvested immediately, you must aim at the international market from the start, you must be ready to establish and defend yourself on it;

- conditions are difficult in certain key sectors, such as the agrifood business: large groups are few, their margins small, common-market rules do not play in their favor.

Finally, the French, scientists as well as manufacturers, like to stay at home. They like their village, their laboratory bench, their factory. They

are not very mobile. Toward advanced technologies, a certain skepticism seems appropriate. "Let's not get carried away; more haste, less speed..."

It was therefore necessary to mobilize... Was mobilization a success?

Situation in 1985

During round tables or interviews, we talked with many people involved in biotechnologies in the public or private sector, high-level officials, decision-makers, researchers, financiers... As usual in investigations of this type, there was more criticism than praise.

First criticism: in France, too many people, manufacturers, decision-makers, politicians, continue to approach biotechnologies as if they were a linear sector like the space or nuclear sectors. The linear-sector approach was successful in France in the past, when there was a single large client, the State. However, in the case of biotechnologies, what we have is a criss-cross of proliferating techniques consisting of a multitude of cross-breeding disciplines. Strategy, in that case, should be to occupy the strategic poles of knowledge--enzymology, microbiology, food toxicology, etc.--conquer them and hold them firmly. In military parlance, we would speak of storming the ridges. Supported by such strategic poles, it is then possible to develop disciplines as a network. We must not be obsessed by the market alone--which often remains to be created--by "market niches" alone, at a time when our major competitors are already busy locking in entire sectors, microbiology for the Japanese, genetic engineering for the Americans.

Another criticism has to do with the mobilization of financial resources. In their strategy of conquest, the Americans were helped by venture capital, which made possible the creation of numerous small biotechnology companies: over 250 in the United States, compared with 2 now operating in France (3 more are currently being created)...

French capital is not keen on ventures. The fact that numerous small U.S. companies could drain large capital masses even before they could consider their first sale of licenses or products, the fact that all are still operating in the red, will not encourage French investors. However, this analysis--French money is allergic to ventures, which impedes the rapid development of biotechnologies in France--is not fully shared by financiers. Finding $2 million (the average amount needed to start a small genetic engineering company in the United States) is possible in France. But the financial groups tempted by such a venture--knowing full well that when the initial capital is spent additional financing will have to be found--feel that they have been offered very few "good projects," i.e. projects including serious evaluation studies and prepared by credible "developers," well informed scientific people aware of industrial conditions and decided to go for it.

Underlying this observation of financiers, there is a basic criticism: we can make do without venture-capital companies, but not without project leaders in applied-goal basic research. There are actually a few researchers in France who play that role. But this function in public research was not identified, recognized... and honored. We should stress that this func-

tion is not a secondary one: it requires the best, the most imaginative and also the most realistic, the most enthusiastic and also the most rigorous. "People who believe that research is a struggle like industrial life." Transfer "from basic to applied research" is not just a matter of communication. It involves a transformation of the initial idea, which a former basic researcher is most qualified to effect. The creation at regional level of Transfer Centers and biotechnology poles is a first step in the right direction.*

Third criticism: despite the mobilization effort, manufacturers hesitate to embark on pre-industrial biotechnology research. Why? Manufacturers are thinking in terms of products, while biotechnologies today are busy developing the tools that, tomorrow, will yield new products. Let's compare this with data processing. The latter appeared around 1955, 20 years before biotechnologies, during which it sold essentially services and a few large machines. It was only starting in 1975 that miniaturization made it possible to multiply industrial and consumer "products," the objective being to put a calculator in each pocket, a personal computer in each office and each household. Biotechnologies still have a few years to go before reaching the point where data processing is today, and the industrial sectors concerned (pharmaceutical, chemical, agrifood industries) are not always in the habit of thinking in terms of the "tools" that will open the door to "products"... later on.

Finally, although, as no one will deny, high-level basic research in France is excellent, there are still too few high-level researchers in advanced biology. Also, there are gaps. For instance in microbiology (a decision was made to create a microbiology center at the INRA [National Institute for Agronomical Research]); plant genetics (researchers of quality, but still too few); bioengineering (the specialized equipment is seldom French-made).

This criticism as a whole is the expression of a regret. The program achieved a psychological "mobilization." Without it, they say, nothing would have happened. The message has been heard. "The survival of French industrial independence is at stake: if tomorrow, in the race to innovation, we fall behind the leading pack, we shall become subcontractors." However, due to prevailing conditions, lack of flexibility--and prohibitions--in certain organizations, and due also to the resources, especially financial resources, made available to the program, it failed to carry everybody along. Thanks to sound strategic decisions, as is witnessed by the analysis of its action that we are publishing on page 14 [not included], it set the machinery in motion: the fundamental research-applied research-predevelopment-development spiral has started rotating. But the situation remains difficult.

Pending Problems

1. Too Few Industrial Researchers

First, contrary to the U.S. system, the French research system is excessively partitioned: public research on one side, industrial research on the other.

* For a more detailed analysis, see the article entitled "Biotechnologies in the Regions" [not included].

In the United States, the most prestigious universities derive part of their income fron industrial contracts. The same researchers are now professors, now industrial researchers, the former working in part as contractors to the industry, the latter submitting and collaborating to contracts. This has proved a choice ground for the growth of biotechnologies; high-level academics, the most enterprising among the best, created venture-capital biotechnology companies and, oddly enough, they did so at no great personal risk: they invested little money and if they failed (which, in the United States, is not a fault) they could still return to the university. Thus creating his company, the researcher became project leader for applied-goal basic research: whenever the germ of an application became evident during the most basic research, he seized it, hatched it in a pre-industrial environment, methodically researched all fields in which it could be used, and advanced development to the point where he could sell a technology, more rarely a product, or even sell the company itself to a large group.

The situation in France is not like that.

2. The Link Between Research and Industries Is Not Yet Close Enough

One of the merits of the mobilization program is certainly that it encouraged collaboration in the field between academics engaged in basic research and public or industrial organizations, that it convinced these partners that their symbiosis was urgent. Certain groups do not hesitate to create joint laboratories with a public research organization, and consider that their working relations with universities have considerably improved in the past three years. The link is most effective when the basic researcher finds in industrial research a scientist of adequate level, who asks him the right questions and with whom he can engage in a true dialogue. It is only when corporate management includes or is assisted by "able" scientists that messages from basic research can be heard, announcing future technologies, warning that their advent will change the rules of the industrial game, even if it is still too soon to put products in front of the board of directors. Certainly, there are enthusiastic manufacturers, crazy about innovation. But, understandably, many others, confronted with daily problems, are confused and cautious. In that case, too, the convincing power of a project leader can play a decisive part as a catalyst.

3. Researchers' Behavior Remains Ambivalent

Although relations have improved, much remains to be done to convince researchers that the problem on which the manufacturer consults them is sophisticated enough to earn them "academic" laurels if they solve it. In the subconscious of all researchers, a Nobel prize is lurking. A "nice publication" is more attractive than an innovating achievement. Yet, the wind can turn and we all know researchers of the highest level who tried their hand at industry and got to like it. But this is a slow evolution. As a whole, like all French people, researchers are not very mobile, they are tied down by their status, their lab, their subject matter. Most of them will accept to work as consultants. Few are prepared to take the plunge, to get involved more than just a little, much less to create their own company.

Besides, even today, the career of university researchers working on application projects is handicapped. The publications that will earn them recognition and enable them to apply for jobs, if they deal with applications, are still too often ill-considered by the university hierarchy and, in addition, often delayed by the need for industrial secrecy. It is still difficult, in French universities, to create the jobs required to develop a technological opening and, when these jobs are created, the critical mass required to advance the project is seldom achieved.

Relations between university research and small or medium-size industries, seed-growers for instance, remain difficult: lack of a receptive scientific structure, lack of technical and financial capacity for long-term development. Indeed, the researcher interested by an application is unable to organize his research policy if he works only with small or medium-size industries. He needs large groups to express himself.

4. The Demand for General and Specialized Biotechnologists Is Still Not Met

Small and medium-size industries, in particular, could use the services of "general" biotechnologists, a name that infuriates high-level researchers, for who could claim to be truly competent in the various disciplines from which biotechnologies are issued. It is a long way from cutting DNA to piloting a bioreactor. But a small or medium-size industry will have to give up innovation if it does not possess a scientist capable of talking with outside consultants in various disciplines. Undoubtedly, the European Biotechnology Federation is right when it advises to promote this type of training. In addition, both in large groups and in public organizations, to draw up and implement a research policy, high-level generalists with great scientific culture are needed, who may not be operational in all disciplines, but must have good reflexes in all. These generalists are seasoned specialists who were trained on the job to understand related disciplines. This presupposes that they had a diversified professional experience, that they travelled back and forth between universities and the industry, from the most basic research to applied research, and therefore that they accepted this mobility which is still not much appreciated by many French researchers.

Of course, biotechnologies also need geneticists, immunologists, biochemists, "leading-edge" mechanics. These are the type of researchers recruited by U.S. biotechnology companies. They are placed in teams who think biotechnology, i.e. "concerted" use of the various biotechnological tools. Just as conservatories have chamber-music classes, universities should create courses to teach thinking in terms of a multiplicity of tools.

5. The Mobilization Program Is No Longer Enough

The level of research activity generated by the mobilization program is still modest compared with the formidable buildup of U.S. and Japanese research efforts. As for the industrial environment, it has not fully responded to mobilization. We have seen cases where a public sector researcher, struggling to find a French manufacturer to take over an already ripe project, already had three or four proposals from foreign manufacturers. And we must also recall that some French industrial sectors employ very few research personnel:

1,060 public and private research engineers in the agricultural and food industries in 1981, less than in one large multinational in this field.

Besides, is the research effort well oriented? Take the agriculture-livestock raising sector. Some say: we have too many zootechnicians, for we are already producing (and maybe eating) too much milk, too much meat. Actually, if French zootechnicians manage to improve the competitiveness of French milk, their work will have been useful. Far more useful still if, in coordination with agrifood researchers, they make it possible to export competitive finished products, for instance yogurt. But, if we do not have too many zootechnicians, then the agricultural research effort is still too small, in spite of investments recently decided by a few large industrial and financial groups, in France as well as abroad.

In the United States, several hundreds of researchers have been recruited in the field of plant biotechnologies. The same effort was made in Great-Britain. No such thing in France. Thus, in the field of gene transfer in higher plants, all agree that the number of competent French researchers is still much too low.

Research upstream from biotechnologies (genetics, enzymology, immunology, etc.) appears to follow reasonable orientations, and we are not far from having nearly 10 percent of all competent researchers in these fields worldwide. The same is true of industrial research to optimize processes. What is lacking is "transformation" research to make tools and processes acceptable industrially, for instance to define the conditions under which a recombinant bacterium will synthetize a suitable amount of a desired protein.

The logistics required for that--nucleotide synthetizers, amino acid sequencers, etc.--has been neglected. On the other hand, the data-processing support that will enable researchers to take advantage of gene banks and peptide sequences has been created, to the satisfaction of most. In this case too, as in data processing, the French, being more gifted to handle ideas than monkey wrenches, were more successful in creating software than in creating "big machines."

Crossovers between the various techniques were poorly planned. If we look at programs, we find credits allocated to such and such technique, but seldom credit lines covering a promising crossover between techniques.

What Should We Do, Then?

We would be tempted to express our answer in the sports jargon: "Now, we must go for it...":

- first, strengthen our weak points: equipment, microbiology, plant genetic engineering;

- convince the industry to commit itself. Certainly, the large groups that are most directly concerned, such as Rhone-Poulenc, have made their investments a long time ago, and the renewed commitment of Roussel-Uclaf and SANOFI [Aquitaine Financial Corporation for Hygiene and Health] shows that some

industrial sectors are ready to answer the call. But other sectors, such as the agrifood sector, should no longer hesitate:

- we must accelerate the removal of partitions between universities and the industry, by encouraging the nascent taste of young researchers for the industry and encouraging those who want to become project leaders;

- the procedures for contractual financing of research must be made more flexible. Collaboration between university basic research, transformation research, industrial applied research, can take various forms: project financing through research contracts; demand financing through the ANVAR [National Agency for the Implementation of Research]; where a joint university-industry project exists, the program can take over the upstream side, the ANVAR the downstream side. Many other financing arrangements are possible, for instance through subsidiaries of public organizations working in partnership with industries.

Finally, the main question remains this: who will examine this collective effort, who will "implement"? It is difficult to find a consensus on this point today. The mobilization program has made the scientific and industrial community aware of the urgency of biotechnologies. But, if we are not to founder, we must now engage the next higher gear: we must make choices and concentrate all available forces on these choices.

Those to whom this task will be assigned will first have to break down the complex overall potential for application of biotechnologies into scientifically consistent subassemblies and, after thorough evaluation by independent and renewable experts (scientists, economists) chosen theme by theme, set an order of priority for large application projects.

When the actors of each subassembly are identified, a leading national or regional organization or a partnership between a public organization and the industry could then be entrusted with implementation. But, in all cases, responsible project leaders possessing actual power would be appointed to provide management, leadership... and follow-up, which is no small task as it involves working in the field, seeing how money is used, preventing the amounts granted from strengthening the position of uncreative researchers, of "me-too's," making sure that the companies involved do benefit from the research, being capable of reorienting, even stopping, which is a source of frustration and conflicts.

What status should this leadership structure have? Should an "agency" be created? Some fear that controlled planning, which that word seems to imply, will inhibit creativity. Yet, after due consideration, it is what we suggest to do. The agency will be responsible for making selections, but it will delegate its powers to project leaders responsible for the implementation of the projects selected. In our opinion, this will be a light structure, a "force of intervention" unlikely to turn into a giant, and possibly temporary, consisting of a few resolute scientists and manufacturers on temporary assignment, created at the initiative of the ministry in charge of biotechnologies--today, the Ministry of Research and Technology--but enjoying a broad autonomy of decision. We should not overlook the fact that

such a structure can succeed only if it can transfuse into operational units not only money, doing this under its sole responsibility, but power as well. We are not talking about setting up a new administrative superstructure, but about establishing a competitive setup.

The European Wager

This being said, any leadership structure will be powerless, at least in the long term, if it is not geared to Europe, especially since the success of technological consultation projects within the EEC could be one of the most effective cements of political unification.

Projecting that France will have gained 10 percent of the world biotechnology market by 1990 no longer means much. Besides, the world biotechnology market is a fuzzy set that does not lend itself well to arithmetics.

The real wager that we should make is this: "By the end of the second millenium, Europe will be the second of the three biotechnology leaders: United States, Europe, Japan..." at a time when the following scheme is becoming apparent: two leaders, the United States and Japan, and European nations scoring a few successes but essentially doomed to subcontracting.

We can--and we must--win this wager. Making a wager on a European scale does not mean relieving France of its responsibility. For one thing is certain: the wager cannot be won without France, without French basic research, without French agriculture, without the French agrifood business, without the French pharmaceutical industry...

One of the tasks of the "Europe of biotechnologies" will be to accelerate the development of common standards and regulations. Today, the various European countries tend to align themselves de facto on U.S. and soon Japanese standards. The country that imposes its standards will enjoy a decisive advantage on the international market. But, in advanced technologies, those that do not aim at the international market are doomed to lose.

The most important task will be to create a pre-industrial application research program for European biotechnologies.

To develop information technologies, the Europeans just adopted the ESPRIT program [European Strategic Program for Research and Development in Information Technology]. It is briefly analyzed in the boxed insert opposite [not included]. Europe is not lagging behind in biotechnologies as much as in information technologies, a field in which it covers less than 10 percent of the world market. But biotechnologies and information technologies are facing similar growth problems: fragmented European market; national markets that are too narrow compared with the single U.S. market (230 million people) or even the Japanese market (118 million people); large overall research budget but inadequate budget in each country and in most large groups (whose sales are in most cases well below those of their U.S. counterparts) so that an adequate critical mass cannot be reached.

The ESPRIT program adopted by the council of European research ministers last February and dealing with European research in information technologies focusses on technological factors whose control will command the long-term development of information technologies. The research considered is of a pre-competitive nature, so that several firms of various nationalities, which otherwise compete on the market, can participate in the same research consortium.

A European program for goal-oriented biotechnology research could be inspired by the ESPRIT structures. It might be called the BEST program: "Biotechnological European Systems Team." This program would complement the "biotechnology" action program to which the European Commission is putting the finishing touch.* Since biotechnologies have not yet reached the data-processing stage, and since the research considered does not directly affect the economic interests of EEC member countries, it might be a good idea to associate other European countries to the BEST program (Sweden and Switzerland, for instance), taking care of first solving any problems that this opening could pose.

If these suggestions were taken into account, and if one of our readers were to ask: "Is BIOFUTUR, the European biotechnology magazine, optimistic?" we could answer: "Yes. We want to be optimistic because optimism conditions the will to succeed. And today, fierce determination is necessary to win the wager that Europe, and France with it, will be the second of the three leaders in biotechnologies by the year 2000."

Lack of Scientists in Microbiology

Paris BIOFUTUR in French Dec 84 p 23

[Article by Betty Dodet]

[Excerpt] The Situation in France

France is not well placed as far as microbiology is concerned; it suffers from a shortage of researchers in this field. It lags far behind the United States and Japan. Its position with respect to Europe is illustrated by a recent report of the EEC listing major microbial physiology research units. The report lists 82 French units, compared with 395 for Great-Britain, 183 for the FRG and 119 for the Netherlands.

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* It proposes to act in two directions. First, to intensify training, the dissemination of knowledge, and information on biotechnologies; second, to create an environment more favorable to their industrial development. In both cases, concrete steps are contemplated. For instance, the creation of a European network of biological resource banks and biotechnological databases, or again adjustments in the pricing system of agricultural raw materials used by the bio-industries (which are now at a disavantage in Europe, where prices are higher than world prices).

Yet, at the beginning of the century, France did have a strong tradition in microbiology, oriented mainly toward the medical sector. Paradoxically, after the war microbiology suffered from the advance of molecular biology, which turned Escherichia coli into a privileged and exclusive object of study. This, of course, led to a remarkable progress, but it took place at the expense of research on other bacteria and in other sectors of microbiology. Then, in the early 1970's, it was felt that the golden age of the colibacillus as an object of study for molecular biology had come to a close and that the era of higher eucaryotes was beginning. And the study of eucaryotes took place at the expense of research on procaryotes.

Entire sectors, which still constitute advanced or promising sectors, were abandoned.

In addition, the teaching of microbiology, which for a long time was exclusively geared to medicine, was neglected. The only existing full second-cycle microbiology certificate, including courses in the physiology and genetics of eucaryotic protista, was created at the Paris-7 University only in 1973.

However, the last five years were marked by an increasing awareness of the importance of microbiology. The effort made in this field took in particular the form of research grants, the creation of jobs at the National Center for Scientific Research, at the National Institute for Agronomical Research and at the Office for Overseas Scientific and Technical Research, and the development of research programs on new microorganisms. Collaboration between public and private laboratories was intensified.

Much remains to be done, both with respect to personnel training and to financing, to increase the number of efficient laboratories so as to match that of competitor countries.

Research in Enzyme Engineering

Paris BIOFUTUR in French Dec 84 pp 28-29

[Article by Nelly Cochet based on an interview with Daniel Thomas: "Strength and Weaknesses of Enzyme Engineering"]

> [Text] Enzyme engineering is an important component in the development of biotechnologies. Unfortunately, it is not much developed in France. Yet, the few existing teams are of international quality. This article takes stock of the French situation. It is very short, as BIOFUTUR intends to devote a special issue to this subject in June 1985.

Enzyme engineering is nonexistent in France. This is what we might believe if we looked only at the amount of public credits granted. Indeed, as far as the government is concerned, enzyme engineering does not constitute a priority. It is the subject of only two theme-oriented programmed actions: one at the CNRS [National Center for Scientific Studies] concerning protein "design"; and another under the PIRSEM program [an interdisciplinary program for scientific research] on enzyme engineering in general.

Industry Support for Research

If enzyme engineering exists, and if research teams are capable of operating and attaining international level, it is due to the interest shown by many industrial sectors: agrifood, pharmaceuticals, chemistry of cosmetics, water processing, energy. French industries are increasingly led to consider the use of enzymes at various stages of their manufacturing processes. Yet, enzyme production operations are extremely small. Rapidase, which now belongs to Gist-Brocades, no longer exists under its original name since July 1984. A few enzyme production operations for therapeutic and analytical purposes still exist in some companies such as Choay and Sampa-Chimie (Sanofi [Aquitaine Financial Corporation for Hygiene and Health]).

Teams

Research teams are unfortunately too few in France, numbering only three.

Pierre Monsan's team (Toulouse INSA [National Institute for Applied Sciences]) consists of about 15 people working on the use of enzyme engineering in organic synthesis. Pierre Coulet's team (IUT [University Technology Institute] and CNRS Laboratory in Lyons) has oriented its research on the immobilization of enzymes for preparation and analytical purposes. It consists of about 10 people. Finally, Daniel Thomas's team (CNRS Associated Laboratory/Associated Food Enzyme Engineering Laboratory of the INRA [National Institute for Agronomical Research] in Compiegne) has focussed its research on enzymology applications in industries (agrifood, pharmaceuticals, cosmetology, effluent treatment), analysis (enzyme and immoenzymological electrodes) and therapeutics (enzymotherapy). It is the largest French laboratory, with some 60 people.

The forces of enzyme engineering, therefore, are highly concentrated. In basic enzymology, on the other hand, there are several teams working at various universities and research centers (Orsay, Pasteur Institute, Polytechnic School, Marseilles, Gif-sur-Yvette, Bordeaux, Nice).

Looking at it from an international point of view, we can measure how much remains to be done if we are to become a world leader: in Japan, there are about 20 teams of 20 people each...

Research Subjects

The technological aspect of enzyme engineering does not constitute the limiting factor. Indeed, specific problems arising in this field are of a biochemical nature. Even as far as the budget is concerned, the largest items are not those covering equipment, but rather the biochemical purification and immobilization stages. At present, the main lines of development are the following:

- regeneration of cofactors (NAD, NADP, ATP) studied by chemical, electrochemical and biochemical means;

- use of enzymes in organic solvent media, which offers two advantages: elimination of the drawback of hydrolysis in an aqueous medium, and possible use in organic synthesis;

- control of the molecular aging of enzymes in operation, due to the presence of activated forms of oxygen;

- supply of energy in reactors, obtained through the ATP produced by biological organelles (chromatophores of photosynthetic bacteria);

- search for new enzyme activities, both from new enzyme molecules and from existing proteins. At present, there is much talk of using hemoglobin as an enzyme. Also, activities could be modulated by altering proteins chemically or through controlled mutagenesis (protein "design").

Protein "design" can result only from a large amount of research on the X-ray structure of proteins, molecular signatures, DNA alteration and, finally, cloning.

While some teams are heading in that direction, we should in this respect stress the interest of research based on multidisciplinary work. Also, it would be desirable to pursue the implementation of close collaboration between enzyme engineering and basic enzymology laboratories.

Research at the Fournier Laboratories: "A Burning Necessity"

With 130 researchers and technicians working since January 1983 at the new Daix Center, and an operating budget of FF 50 million, i.e. 15 percent of pharmaceutical sales, research at the Fournier Laboratories evidences a dynamism and will to succeed that resulted, to give an example, in the signature of a framework scientific-collaboration agreement with the CNRS.

Eager to maintain the diversity of their operations and, therefore, to diversify risks, the Fournier Laboratories are taking advantage of all the synergisms that a group of companies can provide: thus, the High-Polymer Research Center, upstream from the operations involving industrial (Plasto) and medical (Urgo) adhesives, is working in close collaboration with the Galenic research team to develop capsule matrices and new technical processes to produce programmed-release drugs or new methods to administer them.

Pharmaceutical research is oriented mainly to the treatment of atheroma, and in particular disorders of lipid metabolism, a field in which the Fournier Laboratories have acquired a leading position with close to 40 percent of the European market. Immunology and vascular diseases are two other of their priorities.

Thanks to long-term collaboration contracts, scientific and technical assistance agreements, grants for the completion of doctoral theses, etc., many links have been established between research laboratories and universities or French and foreign scientific institutes. Thus, the framework agreement signed with the CNRS establishes a network of researchers, as specified in 19 contracts or conventions with 15 units of associated laboratories.

The development of the Fournier Laboratories, therefore, amounts to an innovation process to meet the standing challenge of maintaining a strong presence on the domestic market and meeting the need for continued action to develop the Laboratories' share in the face of international competition.

To achieve this, we believe in the effectiveness of allying the creativity and development efforts that can be provided both by university laboratories engaged in basic research and by industrial laboratories with their multidisciplinary components and their knowhow in goal-oriented research.

It is in this spirit that the Fournier laboratories are indefatigably pursuing the objective of scientific enrichment of the regional environment.

Research in Genetic Engineering

Paris BIOFUTUR in French Dec 84 pp 31-33

[Article by Betty Dodet: "Genetic Engineering in France"]

[Excerpts] The basis of the biotechnological revolution, "genetic engineering has become commonplace so fast that it is heading for oblivion; soon, it will no longer even be mentioned, just as other research tools such as centrifuges are no longer mentioned." This is how Philippe Kourilsky illustrates the evolution of this advanced set of methods. What is the present status of genetic engineering in France? This article will attempt to answer this question.

The Situation in France

We must distinguish two aspects in the progress of scientific knowledge: progress in the methods used, and progress in the basic knowledge that is made possible by the use of these methods to study microorganisms and cells. Although research done in France is of a good overall quality, not much of it is done.

First, we learned how to manipulate genes in E. coli, then in other bacteria, then in yeasts, in animal cells and, finally, in multicellular organisms. Microbiology, therefore, was the first to benefit from genetic engineering. However, although the French Microbiology Society counts 1,200 members, the level of French microbiology is not very good and the quality of the various laboratories is very uneven. Much research has been done in France on E. coli; a few teams are now working on Bacillus subtilis. This research is qualitatively good, but quantitatively small. On the other hand, the situation is definitely poor as far as Actinomycetes are concerned. In France, very little good research is done on antibiotic-producing microorganisms through modern methods of genetic engineering. The field of lactic bacteria assumes considerable interest, for these are quite likely to play an important part in the agrifood industry. But, in this case too, France does not appear to be well placed, in spite of the existence of a few very efficient teams, one of them at Transgene.

On the other hand, France possesses a few laboratories with a very good reputation, specialized in the study of yeasts through genetic engineering, in particular at Gif-sur-Yvette and Strasbourg. France is in a good position for the genetic study of animal cells, with a few very good laboratories, such as those of Pierre Chambon in Strasbourg, Francois Cuzin in Nice and Pierre Tiollais, Francois Rougeon and Philippe Kourilsky at the Pasteur Institute in Paris. The situation is less brilliant when it comes to genetic engineering applied to animals.

Finally, as far as genetic recombination of plants is concerned, the situation of France is quite poor, although there are a few very good teams at Orsay, Versailles and Toulouse, at the INRA [National Institute for Agronomic Research] and at the CNRS [National Center for Scientific Studies]. But advanced-research teams are far fewer than in other countries.

Improving the Research System?

Genetic engineering started early in France: already in 1973, Alain Rambac, then Pierre Tiollais, began to develop the first vectors at the Pasteur Institute, and they were joined the next year by Philippe Kourislky. But the introduction of new genetic engineering techniques in the various research oganizations often met with resistance, which still persists even now that they have become commonplace.

The structures and management methods of French research organizations have not always promoted the integration of these new techniques.

The CNRS appears to be the organization that best manages its research in this field; the INSERM [National Institute for Health and Medical Research] has improved in this respect. The INRA, with missions working on relatively applied research and with decentralized structures, has not well digested molecular biology. It is true, however, that this was not always consistent with its major missions. Yet, every research organization should make sure that an adequate percentage of its activity integrates the new technologies, as long as it is known that they are destined to play an important part.

As far as universities are concerned, the structure set up in 1968 evidenced a few drawbacks which the Directorate of Research at the Ministry of Education is busy correcting: indeed, the independence of universities, which enables them to implement their own research policy, has not always led to a very rigorous evaluation of what was best for universities and for the country.

Thus, it is quite possible that the French research system is not truly operating at maximum efficiency. At least, it appears to be less efficient than the English system.

Public Research in Immunology

Paris BIOFUTUR in French Dec 84 pp 44-47, 51-52

[Article: "Immunology in Public Research"]

[Excerpts] This article consists of excerpts from the report of the INSERM [National Institute for Health and Medical Research] Specialized Scientific Commission No 3 (February 1984; chairman: Jacques Theze; subcommissions headed by Messrs Kazàtchikine, Mawas, Tursz and Charron). For more details, in particular for the conclusions and course of action suggested, please refer to the full document available from the commission chairman.

Thematic Developments

Structures and Molecules of the Immune System

Research on immunoglobulin genes has made tremendous progress since the discoveries of Tonegawa, Hood and Leder. As far as original observations are concerned, French contributions were not really outstanding but the whole field is now covered. One large French group (the Pasteur Institute) is not involved in the programs supported by the INSERM.

Research on antibodies and their sequence is a traditional field in immunology, but the methods used by our teams often remain too traditional (no truly operational protein microsequence as yet). Since Oudin's observations, research on the idiotypic determinants characteristic of specific antibodies has been of very good quality and internationally recognized (U.136, Pasteur Institute).

In the field of products and genes of the major histocompatibility locus, French research has scored important points, due in particular to work carried out under the direction of J. Dausset. At present, genes coding for transplantation antigens (Class 1) are well researched at the INSERM; on the other hand, no group is studying the genes coding for Class-2 products involved in cellular interactions. However, the biochemistry of Class-2 antigens is of excellent quality and rivals with the best teams.

The subject of cellular receptors enjoys a privileged position in immunology, as it concerns antigen-recognition structures, regulator or effector molecules, and intercellular recognition. These subjects are researched by 10 groups or so in various units, and their research is in most cases competitive at international level. At the INSERM, this new field has developed in most cases from cellular immunology; however, researchers seem to lack the knowhow required to be highly operational. Research on specific antigen receptors has recently progressed a lot in the United States, without any French contribution. As a rule, this research should benefit from contacts with other disciplines interested in the "receptor-ligand" interaction, such as neurophysiology or endocrinology. Note that our commission does not include teams

researching intracellular transmission of signals after the bonding of a ligand to its membrane receptor.

Research on the complement is now competitive in several fields but, in the intermediate term, it will have to avoid a certain dispersion of efforts and acquire new methods, in particular in cell biology. Research on the genes of the major histocompatibility complex coding for C4 and C2 represents a considerable part of the program of the unit created in 1984 by Specialized Scientific Commission No 3.

Cells of the Immune System: Functions, Interactions and Mediators

INSERM or INSERM-supported teams have made a special contribution to the study of the ontogenesis of various cell populations, and to the study of the part played by the thymus in this maturation. Eight units are involved in research of this type. Simultaneously, the study of congenital immunity deficiencies provides and uses information in this field.

A few teams have made essential contributions with respect to the regulation of the quality of the antibodies produced. Research on the regulation of the production of a specific idiotype and on the manipulation of the immune response through anti-idiotypic reagents is of very good quality. Research on isotypic regulation, i.e. the analysis of the mechanisms leading to the expression of classes and subclasses of antibodies having different functions, is internationally recognized. Research carried out in this field is published regularly in excellent international journals.

The study of cytokines and lymphokines is a field in full development. Eight units are now involved in this research, which should prove essential to the understanding of the mechanisms leading to selective clonal expansion and to the regulation of cellular interactions. In this field, most teams have been able to adjust to modern technologies and develop them (cell sorters, lymphocyte culture, monoclonal antibodies, etc.); as a whole, they are excellent.

Immune Defense and Tolerance

Immunology was born from research on the defense of the organism against agents of infection. Preventive means (hygiene, immunization) and therapeutic tools have reduced the importance of infectious diseases in developed countries, which in turn brought about a certain disinterest for research in bacteriology, virology and medical mycology, and a quantitative collapse of anti-infectious immunology. However, the problem remains entire in other countries with, in addition, parasitic infection problems. The eradication of infectious and parasitic diseases in Third-World and Fourth-World countries is not conditioned by the progress of research; however, the definition of the corresponding biological problem can be considered to be an important parameter when programs to eradicate these diseases are being set up. Under these conditions, it is hard to understand why only one INSERM unit is interested in antibacterial immunity (U.65), only one unit supervised by Specialized Scientific Commission No 3 in antiparasitic immunity (U.167), very few units in antiviral immunity, and none at all in antifungal immunity.

Reproduction and/or foetus-mother tolerance immunology is of considerable fundamental interest. It is a field that is well represented at the INSERM, but whose future development is not assured.

Immunopathology

Immunopathology, conceived as the study of deficiencies and perversions in the operation of the immune system, is the subject of active high-quality research at many INSERM units.

Implementation of Research in Immunology

A great many teams are engaged in research in immunopharmacology, immunomodulation and monoclonal antibody production for diagnostic or therapeutical purposes.

Research in the field of immunopharmacology is usually good, sometimes very good (U.200), but it would deserve regrouping to prevent redundancies and lack of efficiency, as there appears to be now some disproportion between the number of teams and the results achieved.

In the field of monoclonal antibodies, the essential innovation is the creation of Immunotech. The considerable interest of monoclonal antibodies, mentioned throughout this report, deserves that INSERM continue its efforts in this direction.

Structures

INSERM units studying immunology are mostly located in Paris (14 units out of 21, i.e. 66 percent); 11 of them are in a university hospital environment, but their relations with universities are very uneven, depending on the unit.

In the provinces, there are two very large centers: the INSERM-CNRS Immunology Center of Marseilles-Luminy, which is the equivalent of at least four or five units; and the Parasitic Immunology Center of Lille, equivalent to two or three research units, but in which the INSERM has only three researchers and no technician...

Immunology is extremely well represented at the Pasteur Institute (Metchnikoff Center), with a single INSERM unit created this year and an impressive concentration of researchers covering the most modern aspects of immunology (CNRS, universities, Pasteur Institute).

The CNRS, science faculties, university hospitals, blood-transfusion centers, some cancer-prevention centers, the INRA, some veterinary schools and the Atomic Energy Commission, all have immunologists in some locations, and their diversity, geographical dispersion and sometimes their excellence complement the structures of immunology.

Apart from a few large institutes, immunology is therefore quite heterogeneous in its installations, in the training and origin of its researchers, their administrative status and their goals.

INSERM Personnel in 1975 and 1982, in Units Now Supervised by Commission No 3

Category	1975	January 1984
Number of units	17	19 (+2 created in 1984)
Number of INSERM researchers	106	117
Number of directors	1	3 (incl. only 1 unit director)
Number of senior researchers	9	28 (4 of whom head a unit)
Number of researchers	96	83 (10 of whom qualify to become senior researchers)
Number of research assistants		3 (to be promoted researchers in 1984)

The Place of France

Basic research, both in immunology and in molecular biology, is certainly good qualitatively, but it is inadequate quantitatively, both due to the fact that these two disciplines are recent and to the recruiting policies of the past 15 years, which did not adequately take their potential into account. Thus, therefore, major specialized companies have trouble recruiting researchers in France and must hire foreigners. The best researchers hesitate to leave their institutional laboratories and, too often, those who go over to the industry or implementation structures are "second best."

Finally, too few French manufacturers, including in the nationalized sector, know how to make their research and development projects (when they have some) attractive. Therefore, in too many cases, they choose to have recourse to incentives offered by the State, such as the delegation of researchers or contracts with State organizations... This places them in a situation of safety without risk, but also without any actual obligation to succeed.

Researchers, manufacturers and the public have become a lot more aware of the role of biotechnologies in the French economy than they were at the time when Mr Aigrain's policy was looked down upon as "piloting from downstream." Yet, after the flights of oratory of the National Symposium on Research and Technology, if the French policy in this respect is not to remain a dead letter, two of its basic aspects must absolutely be settled.

Companies Interested in Biotechnologies Must Become Professional

Too often, these companies represent, in men and in investments, structures on a scale that cannot be compared with their counterparts in North America or even in Europe. The quality and critical mass of their researchers are excellent in some cases (in particular in genetic engineering), but the critical mass of advanced researchers remains small in general when it comes to the applications of immunology. The definition of original market niches suffers from it and is too often replaced by a multiple specialization that weighs heavily on their competitiveness. An excuse for some research institution or nationalized groups, these "chemist's shops or stores" have not yet learned to dialogue with the industry, creating the disturbing impression of a mosquito hovering around an elephant. Actually, too few of

them possess experienced men with a good knowledge of the world of the pharmaceutical industry or medicine; scientists, academics or bankers are no guarantee of the quality of a marketing policy.

Access to Genuine Venture-Capital Financing Must Be Provided

Some specific characteristics of the French market--including the protection of savers since certain financial ventures of the end of the last century--are roadblocks preventing the leaders of biotechnological companies from gaining true access to venture capital (or venture savings) so that, too often, they are supported only by institutional capital. The consequences of this are many. Starting with a capital 10 times less than that of an identical company in North America, the French company receives public assistance from the start: delegation of researchers, priority right of inspection of institutional research, tax preferences, exceptions to corporate law and, above all, lack of a true "market risk" in the liberal sense of the term.

A Good Start If...

Yet, in France more than in most other industrialized European countries, but much less than in the United States and Japan, biotechnologies are taking up positions. They could soon secure part of the European or even of the international market, but only if this new industry becomes professional, if it becomes "economical" by gaining access to venture savings, if it takes care of its own international marketing through national pharmaceutical manufacturers, and if excellent scientific quality is encouraged by releasing the financial forces which alone can attract the most competent scientists of the country to competitive firms.

Lacking this, French researchers may end up contributing only to the development of foreign biotechnologies or, like one branch (ORIS [expansion unknown]) of the Atomic Energy Commission (CEA), marketing North American biotechnology in France (Centocor) and doing so with French taxpayers' money!

Lab Equipment Suppliers

Paris BIOFUTUR in French Dec 84 pp 67-68

[Article by Nelly Cochet: "Equipment and Instruments Made in France"]

> [Text] Durable goods account for a large part of bio-industrial markets. Are French manufacturers seizing the opportunity to develop them in order to reconquer the domestic market?

To "furnish" a laboratory, whether public or private, a number of pieces of equipment must be acquired, which fall into three categories: standard and small equipment, analytical equipment, and culture equipment. As far as the industry is concerned, the heavier equipment will be either designed by the company itself, or purchased from more or less specialized manufacturers.

Equipping a Laboratory

First, a large part of the equipment budget of a laboratory will have to be spent on hollow-ware, centrifuges, autoclaves, laminar-flow hoods, water and air treatment, and to put the products under the proper form (distribution, freeze-drying). In view of the amounts involved, the acquisition of a piece of equipment is conditioned by several elements, which obviously include price, but also servicing.

French equipment suppliers are rather few. A few names were repeatedly mentioned during our survey, possibly reflecting a dynamic marketing policy, such as Jouan (centrifuges), Testut (scales), Tacussel (pH-meters), Jobin-Yvon (spectrophotometers), SFEC [expansion unknown] (ultrafiltration), Nachet (microscopes), Pointet-Girard (chromatography), Intersmat (gas chromatography) recently taken over by Delsi, Lequeux (autoclaves) or Bonnet (cold rooms)... We should also mention Apelex (electrophoresis), Heito (pH-meters, fermenter regulators, agitators, etc.), Medisysteme (radioprotection), Nermag (mass spectrophotometry) and Spiral (chromatography). In sectors such as glassware, laminar-flow hoods or washing equipment, several French manufacturers are represented on the market and can provide reliable equipment at competitive prices. But finding a French-made laboratory atomizer or peristaltic pump is quite a feat!

When it comes to equipping a pilot hall, there are of course several French companies which can manufacture the hollow or plastic ware required (for instance BSL [Bignier, Schmid-Laurent]). Steam production, a must at this stage, requires some major equipment; good French companies are represented on the market.

The "culture" aspect, involving in most cases small or large-volume fermenters,[1] is illustrated by the success of small or medium size industries such as Biolafitte and SGI (Setric Industrial Engineering). Thus, Biolafitte derives 65 to 70 percent of its revenues from export sales, half of which in the United States where the company holds 25 to 30 percent of the market for small-volume fermenters. In France, Biolafitte supplies 85 to 90 percent of all laboratory fermenters. As for SGI, it is more particularly oriented toward promising fields: animal and plant cell cultures, bioreactors, automation and specific enzyme catchers (measurement of lactic acid).

As far as advanced technologies and sophisticated equipment are concerned, the French show a total lack of interest. In a previous article[2] BIOFUTUR published a list of companies manufacturing automatic equipment for the synthesis of oligonucleotides and protein sequencers; all these companies were American or Canadian. Since then, four or five European companies have started offering also this type of equipment. But no French manufacturer, however, has considered that there was a market for it!

1. A list of the principal French and foreign manufacturers of fermenters was published in BIOFUTUR (September 1982).
2. Industry and Genetic Engineering, BIOFUTUR No 6, September 1982.

One Example: Elf Bio-Research

The Elf Bio-Research Center of Labege (Haute-Garonne) which was opened in March 1984 but is not yet fully equipped is an interesting example. Selection of the equipment was done in two stages: the researchers consulted with one another and submitted proposals as to the equipment they would have to handle daily and from which they expected a certain reliability and ease of use. The decision was then made based on prices and a certain desire for standardization.

The equipment budget allocated in 1983 amounted to FF 20 million, plus FF 15 million in 1984, and a little less in 1985. The "fermentation" sector alone accounts for half the cost of the facility. Among the fermenters installed at the center, the Biolafitte brand is the most widely represented. With the exception of this field, most equipment is of foreign origin. However, we should note that, as far as filtration is concerned, Eurofiltec filters and Rhone-Poulenc membranes were purchased and are now being tested.

And in the Industry

The fermentation industries, such as antibiotic production and brewery, have been led to design their own equipment and subcontract vat manufacturing to hollow-ware firms (ACB [Brittany Workshops and Construction Company] and Creusot-Loire for instance). In recent years, Rhone-Merieux started designing and manufacturing its own fermenters. It began with simple laboratory fermenters and is now producing its "biogenerators," a term covering the "vat, accessories and regulation apparatus" assembly. In large companies, this activity reflects a desire for independence which was confirmed as years went by, for being independent of subcontractors has become a necessity in view of the problems encountered in maintenance. Cost reduction is also an argument of consequence in favor of this policy.

As far as industrial equipment is concerned, we find a few French manufacturers already represented in laboratories, but in smaller numbers: SFEC and Rhone-Poulenc (filtration), Pointet-Girard (chromatography), SRTI-Thomson (electrodialysis), Robatel (centrifugation), Nordon and BSL (fermentation vats), Missenard Quint Industries (fermenter agitators), Gauthier Filters (press filters), Cellier (automation of fermenting plants), Goavec (fermenters and equipment for the dairy industry) as well as Robin (engineering and agitators) and Seres (enzyme analyzer). Entire sections of the market are held by foreign manufacturers, in sectors such as reverse osmosis or liquid chromatography.

We can however welcome some initiatives based on high-level research in advanced sectors. For instance, Biomerieux, a company specialized in the production and sale of reagents, is currently preparing to diversify its operations and enter the field of biomedical instruments. It has already completed the development of a diagnostic apparatus using the analysis of true fluorescence. A partnership between Biomerieux (50 percent) and MATRA [Mechanics, Aviation and Traction Company] (50 percent) is now being formed. It will produce and sell the fluoscope [as published].

However, most of the market for industrial durable goods lies in the agrifood industries (IAA). A survey of the market for durable goods in this industrial sector was published in a previous issue.* The supremacy of French equipment is to be found in sugar refineries, bakeries and cheese factories. In most other sectors, the manufacture of industrial equipment is a field in recession. The alarm has already been sounded. However, foreign competition is so strong (especially the German and Dutch equipment) that it is difficult to reconquer the market.

An Alarming Situation

Why is it that two thirds of the laboratory equipment market are in the hands of foreign companies?

We must mention here something for which the French are often criticized: lack of originality and imagination, and a certain ignorance of the actual needs of laboratories. Their marketing policy is sometimes questioned, especially as far as servicing is concerned. Not to mention, of course, their lack of adaptation to the international market. The absence of a complete and precise documentation at the time of delivery, delays and small inventories are as many arguments that weigh heavily when a piece of equipment is selected.

In this article, we have underlined the weaknesses of the French durable goods market and the total lack of manufacturers, in particular for what we might call "sophisticated equipment." There is however one notable exception, the ATC 3000 of the Odam Company. It is a flux cell analyzer-sorter developed under a CEADEIN [expansion unknown] license.

We can see that some companies are now becoming aware of this deficiency, but no major investment effort is being made as yet in a sector in which research and development are relatively costly.

Research at State Organizations

Paris BIOFUTUR in French Dec 84 pp 77-79

[Article by Marie-Francoise Chevallier: "Biotechnologies in Public Scientific Research Organizations"]

[Text] The scope of this single issue of BIOFUTUR is obviously too narrow to enable us to describe the research themes geared to biotechnology and the structures created to promote the transition from research to technologies in public organizations: CNRS [National Center for Scientific Research], CEA [Atomic Energy Commission], INSERM [National Institute for Health and Medical Research], Pasteur Institute, INRA [National Institute for Agronomical Research], ORSTOM [Office for Overseas Scientific and Technical Research], universities and colleges... This will be

* See BIOFUTUR No 28, October 84, special issue on the agrifood industries.

the subject of a series of articles to be published during 1985. The following text should be considered as a foreword.

To encourage the rapid and competitive development of applied biology, a need that was revealed in 1979 by the report "Sciences in Life and Society" by Francois Gros, Francois Jacob and Pierre Royer, such is the goal that the government assigned to itself in 1982, in particular by setting up the mobilization program "Expansion of Biotechnologies" and promulgating the "Orientation and Programming Law for Technological Research and Development in France."

INSERM

The INSERM does advanced basic research in the biomedical field and is developing technologies equally useful to research on, and development of biotechnologies. The very active development of commercialization and communication missions intended to promote this expansion is thus justified. According to the recent INSERM report on economic conditions and prospects, biotechnologies in the biomedical field involve essentially the production of substance of biological interest through genetic methods and cell cultures, the production and distribution of monoclonal antibodies (by Immunotech, among other companies), the development of new vaccines, the use of DNA molecular probes for the diagnostic of hereditary diseases before birth, and the identification of pathogenic agents and parasites.

Yearbooks on drugs and bioreagents testify to the diversity of fields concerned. As an example, we could mention the production of gamma interferon or growth factors, artificial vaccines against the diphtheric toxin or the hepatitis-B virus, the diagnostic of hemoglobulinopathies, etc.

CNRS

The CNRS, whose wealth of basic research covers multidisciplinary fields, created an integrated biotechnology program in 1981. The departments working on it are those of Life Sciences, Chemistry, Phsycial Sciences for the Engineer, and Research Implementation and Applications.

The program includes two orientations. First, support to basic research deemed to be of primary importance for the development of biotechnologies. Certain ATP [Programmed Thematic Action] research themes were adopted. Thus, in the ATP "Structure and Expression of the Genome in Procaryotic and Eucaryotic Cells," the search for new vectors of expression of eucaryotic genes and the application of genetic engineering metods to the identification and production of molecules of biological interest are financially supported by the integrated program. So is, in "microbiology," basic research on microorganisms of industrial interest. Other ATPs deal with enzymology, molecular genetics and the nervous system, plant molecular biology, etc.

The second orientation consists in encouraging researchers to initiate the development of applications for their research. A specific "implementation" ATP is part of the integrated program. Products and processes applicable in the field of health, environment, energy, agrifood and agriculture were obtained by the CNRS with the help of the Research and Technology Fund.

INRA

The development of biotechnologies takes a different form in organizations such as the INRA. Since its creation, this organization has possessed a tradition of biotechnological research. The INRA is geared to oriented research, and a socioeconomic objective underlies most current efforts. It develops complete biotechnological processes, from basic research to turnkey technology.

What are the INRA's most recent "last-generation" biotechnology developments? They concern three fields: plant products, animal products and the agrifood industry. In the first case, research has to do with plant regeneration and growth regulators (in vitro culture, floral and arboricultural vegetative reproduction), haploidization (barley, cereals, alfalfa), protoplast fusion (colza, tomato), male cytoplasmic sterility (crucifers) and gene transfer (Agrobacterium tumefaciens).

The second field covers the transfer of mammal embryos, poultry genetic engineering, the early determination of the sex of embryos (sexing), prevention and vaccine development for animals (monoclonal antibodies, immunology, etc.). Finally, in the last field, biotechnologies include microbiology and the genetics of microorganisms (fermentation process, wine, milk, etc.), process engineering (automation, sensors, ultrafiltration) as well as the cracking or "refining" of agricultural products.

CEA

At the CEA, an industrial group which, since its creation, has developed research in fundamental biology, medicine and agronomy, there are many biotechnological lines of research. They go from basic research to development-research and the bioindustrial process. They involve the fields of health (bioreagents, marked molecules, etc.) and energy (photosynthesis, solar biotechnology, etc.) but, above all, that of process engineering (ultrafiltration).

The Pasteur Institute

The Pasteur Institute possesses a long tradition in biotechnology in the field of human and animal health as well as in that of microbiology applied to crop-growing, the agrifood business and industry.

Apart from the Genetic Engineering Group (G3), no unit* is exclusively geared to biotechnology. But, as at the INSERM or at the CNRS, many units are developing biotechnological research in their own specific fields.

As far as methodological research is concerned, we should mention, among others, the construction of new procaryotic or eucaryotic vectors for genetic engineering, and the use of cloning hosts other than Escherichia coli, in particular Bacillus subtilis.

* There exists also an economic interest group formed, on the one hand, by the Pasteur Institute, the CNRS, the INSERM and the INRA and, on the other hand, Hybridolab, a laboratory responsible for the preparation of monoclonal antibodies.

In the field of health, the goal of research is to find applications either in therapeutics or in diagnosis: antiviral; antibacterial and antiparasitic vaccines through genetic engineering and chemical synthesis (Heptatitis B, whooping cough, malaria, etc.), characterization either of the proteins or of nucleic acids specific of the pathogenic agents whose presence is investigated.

In the agronomical sector and in the industrial sector, research continues on the biological fixation of nitrogen and on the biopesticides produced by various Bacillus, in particuliar Bacillus thuringiensis. Research on the commercialization of the biomass and of agricultural by-products has to do with the production of acetone and butanol, the degradation of cellulose and the production of ethanol and cellulase as well as the production of methane.

Universities and Colleges

In 1984, the Directorate of Research at the Ministry of National Education launched an invitation to bid on the theme "Biotechnology and Medicines," in connection with the mobilization program "Expansion of Biotechnologie." It also supported a concerted "Agrifood" action jointly with the INRA and the Agrifood Department of the Ministry of Research and Technology. These are only two examples of their activities in the field of research.

Universities and colleges play a basic role in training bioengineers. In Compiegne, Clermont-Ferrand, Dijon, Lyon, Lille, Paris, Toulouse, Strasbourg, etc., diplomas of engineers or technicians in biotechnologies are delivered. Some diplomas were created recently; for instance in Strasbourg. The first promotion of "biotechnologists" in genetic engineering will graduate from the university in 1985.

"Public-Private" Agreements

The development conditions of biotechnologies are demanding. In addition to some imperatives (organization of the rapid transfer of scientific data, multidisciplinarity of projects, mobility and suitable training of researchers) to which public research organizations must submit. The latter understood that "public-private" collaboration was a must.

Many agreements have been signed, and they often remain confidential. Collaborations are set up at an early stage, for research, or later on, at the time of the transfer (Roussel-Uclaf and Rhone-Poulenc agreements with the INSERM and the CNRS, etc.). Associations are being created, with various statutes (subsidiaries, partnerships specialized in biotechnology). This is the case of the Association for Solar Bioenergy Research, Agriobtention, Immunotech and Transgene.

Health Products From Industry

Paris BIOFUTUR in French Dec 84 pp 83-91

[Article by Betty Dodet: "Health: Nothing Has Been Lost, But Can We Still Win?"]

[Text] In the field of health, several French firms have long been developing their operations in the field of biotechnology; these enable them to be well placed in the world market, with products such as vitamin B12, vaccines and antibiotics. Yet, the biotechnological revolution resulting from the irruption of molecular biology and genetic engineering started late in France. Genetic engineering research centers were created in the United States in 1975, and only in 1980 in France. Will this lag harm the French industry?

Whereas the biotechnological revolution in the United States manifested itself through a rash of genetic engineering companies and through the diversification of large companies' operations toward biotechnologies, in France it was essentially pharmaceutical firms, already involved in biotechnologies, which embarked on this type of research. Only one independent genetic engineering company was created, Transgene (Genetica is a fully-owned subsidiary of Rhone-Poulenc Health, working exclusively for its parent company) plus another company specialized in the production of monoclonal antibodies.

In spite of this lag, people in French companies insist that the game is not over and that nothing has been lost yet. Very few truly new products issued of the new biotechnologies have been commercialized as yet. We should mention, however, human insulin obtained through genetic recombination but which is a substitution product, the recombinant vaccine of the Merieux Institute against the scours of calves, the blood-typing kit of the National Center for Blood Transfusion (CNTS), etc. The impact of biotechnologies will not be fully felt for a few more years, and competition will play in the long run. Getting late to the first checkpoint does not mean losing the race.

A Necessity for the French Pharmaceutical Industry

Biotechnologies may well reshuffle the present market. They may lead to entirely new products, thus opening markets to conquest.

Improving Production Processes

For the companies already involved in biotechnologies, the primary goal of investment is to preserve and strengthen the position they now occupy on the world market.

Biotechnologies can lead to productivity gains in the production methods of known products. Production of antibiotics and vitamin B12 as well as certain stages in the production of corticosteroids involve the fermentation of microbial strains. The controlled alteration of the genotype of a microorganism will make it possible to improve its performance. In addition, the use of computers will improve the control of large-scale fermentations.

Rhone-Poulenc, which holds over half of the world market for vitamin B12, and Roussel-Uclaf, also well placed on this market, have therefore become interested in improving fermentation processes and the genetics of production strains. As a result, Roussel turned to Cetus, whereas Rhone-Poulenc called on its Genetica subsidiary. These two firms, which also produce antibiotics, are also making investments to improve existing strains and explore new strains. SANOFI [Aquitaine Financial Corporation for Hygiene and Health] is studying the production of ergot alkaloids through fermentations.

Human Vaccines

Substitution products can threaten products already obtained by other means. This is in particular the case for vaccines to be used on man or animals. The future Pasteur Serums and Vaccines Company will regroup the serum and vaccine production operations of the Pasteur Institute-Production and of the Merieux Institute. It will be one of the three world leaders for vaccines, together with Merck (United States) and Behring. The U.S. industry is said to tend to lose interest in vaccine production, which is not very lucrative. In 10 years or so, the number of U.S. vaccine producers dropped from 9 to 5 (Lederle, Merck, Connaught, Parke-Davis and Wyeth). The prospect of producing new-generation vaccines, which are expected to be more profitable, aroused the interest of genetic engineering companies, such as Genentech, Cetus and Biogen. Johnson & Johnson, one of the giants of the U.S. pharmaceutical industry, is financing much of the research in the field of synthetic vaccines.

The Merieux Institute--a leader in the production of rabies vaccine on human diploid cells--has signed an agreement with Transgene, the first laboratory to succeed in making a bacteria produce an antigen glycoprotein of the rabies virus.

Although the Merieux group believes that the poliomyelitis vaccine it is currently producing through a "traditional" process (albeit on immortal cells grown on microspheres in biogenerators) is of excellent quality and low cost, it must still continue its research on possible production methods involving genetic recombination, in order to retain its supremacy.

The economic stakes of a new anti-hepatitis vaccine are considerable. France was the first country to market a vaccine against hepatitis B, prepared from human blood, and it was closely followed by Merck. Competition to conquer the market is intense (especially in Africa where viral hepatitis represents a huge public health problem). Merck and the Pasteur Institute have also turned to vaccine production through genetic engineering: Merck chose to use yeasts, the Pasteur Institute animal cells. Merck scored points, as it was the first to produce this second-generation vaccine and start clinical tests... The vaccine of the Pasteur Institute, produced on CHO cells, has only reached the pilot-production stage. But it could prove more effective than the vaccines obtained on yeast because, in addition to antigen HBs, it also contains the pre-S antigens of the envelope. The pre-S antigens could play an important part in achieving full immunity.

Veterinary Vaccines

The same problems arise in the field of veterinary vaccines where competition is getting more intense. Johnson & Johnson has just made considerable investments in California; this group, which until now was not represented in the veterinary field, is bent on acquiring knowhow, leaving advanced research to specialized institutes and biotechnology companies.

Rhone-Merieux, which is regrouping since 1983 the former veterinary operations of the Rhone-Poulenc group and the Merieux Institute, has already demonstrated that it had integrated the new technologies, since it was among the first to market a recombinant vaccine against the scours of calves, lambs and piglets. For Rhone-Merieux, production of this vaccine represented an opportunity to "get its hand in."

Rhone-Merieux is also working on a substitute for the present vaccine against the foot-and-mouth disease. Several foreign companies have embarked on research on recombinant or synthetic vaccines. Rhone-Merieux, which is well placed on this market, must therefore invest in this field. Especially as production of a vaccine that would not involve culture of a virulent virus would open the doors of the U.S. and Australian markets. Indeed, at present these countries have given up vaccination and prefer systematic slaughter whenever an occasional outbreak occurs, rather than risk a vaccinal accident.

Merieux is also considering conquering new markets, both in the field of human health and in the field of veterinary medicine, with the production of multipurpose vaccines that would make possible simultaneous vaccination against several diseases. The vaccinia virus would be a good candidate as a vehicle for "coding genes" for vaccinal antigens.

Blood Derivatives

As far as blood derivatives are concerned, a field in which the National Center for Blood Transfusion (CNTS) obviously enjoys a predominant position, the Merieux Institute is attempting to consolidate its position in the production of human albumin. It is now producing a human albumin of excellent quality through fractionation of placental blood; this albumin is reserved for export sales. The Institute is considering the feasibility of production through genetic recombination. Finally, it focusses on the hemophilia market, through research on the production of coagulation factors (factor 8 and factor 9).

Transgene has successfully cloned the gene of factor 9. Industrial development, production and marketing will be provided by the Merieux Institute. Research carried out in collaboration with an INSERM unit in Lyons involve monoclonal antibodies directed against the T-lymphocytes. They could soon replace the antilymphocyte serum now produced by the Merieux Institute.

The CNTS has succeeded in being the first in the world to market blood-typing kits using anti-A, anti-B and anti-AB monoclonal antibodies.

Gaining Recognition With New Products

Biotechnologies pave the road for the production of new molecules whose biological activity is often identical to that of the natural molecules of the organism, which molecules cannot be extracted or synthetized through traditional methods. They open new markets and are quite promising, but they require long-range investments to conquer markets whose size is difficult to ascertain ahead of time.

Only a limited number of French companies are interested in "leading-edge" products. In addition, the need for secrecy does not enable them to disclose all their research.

Vaccines

The potentialities of genetic engineering bring the hope to produce vaccines against diseases which were not preventable until now.

The Merieux Institute is preparing a vaccine against herpes, in collaboration with the team of Professor Roizman of the Chicago University. This is a live recombinant vaccine. It will be the first vaccine virus to "benefit" from genetic recombination methods. Considering the extent to which herpes has spread in industrialized countries, and the problems posed by its recurrent forms, this vaccine will certainly open a large market, in particular in the United States. The Merieux Institute believes it is quite ahead of its competitors. Several other vaccines are being studied, including one anti-gonococcal vaccine and a vaccine against malaria. The research and development potentials of the Pasteur Institute and the Merieux Institute, plus their collaboration with first-rate teams, represent a major asset.

Immunomodulators: From Interferon to Interleukine

Interferon

The multiplication of interferons (IFN), elements of a complex system, has made it difficult to select a program. The results obtained with extractive alpha IFN have been very disappointing. They have discouraged some institutes. However, the possibility of producing IFN through cell culture or genetic engineering has provided new impetus for research. Roussel-Uclaf had become interested in IFN quite early. After a failed attempt to collaborate with the Pasteur Institute, it found a way to collaborate with INSERM (Professor Falcoff) and Transgene. Roussel-Uclaf chose to work on gamma interferon, which it felt was more promising for therapeutic purposes. Clinical tests are beginning.

SANOFI, which at a time had considered developing a beta IFN through cell cultures, finally gave up that project to devote itself solely to interleukines. Other French companies are said to be still interested in it, especially UPSA [expansion unknown].

The Merieux Institute has cautiously started the production of alpha IFN through leucocyte culture, in collaboration with the Weizmann Institute. It

is said that is has no intention to invest in IFN obtained through genetic engineering and would not develop the production of alpha lymphoblastic IFN unless its therapeutic value is confirmed.

If the international market were to take shape and develop, France could not hope to have a strong position. Indeed, it has invested relatively little in this product. Roussel-Uclaf, the company that invested the most in this product, will have acquired some experience of genetic engineering methods and a good knowledge of immunomodulators.

Interleukine

Among the other modulators of the immune system, interleukine 2 represents another approach. It amplifies the effector stage of immunity and specifically stimulates the T lymphocytes. It is capable of reconstituting diminished immune defenses and amplifying a normal immune response. Interleukine 2 could have broader indications: treatment of viral diseases (including AIDS), cancer, adjuvant in vaccination.

Two production methods can be considered: cell culture through the stimulation of lymphoblastoid cells, and expression through genetic engineering. SANOFI chose to study the first method, Roussel-Uclaf the second, in collaboration with Transgene. International competition is also fierce for this product. Last July, SANOFI and Roussel signed a cooperation agreement to pool the resources required for preclinical and clinical tests. Each of the two cosignatories will continue to explore the method of its choice, at least until final results tip the scales in favor of either of the two methods. Other immunomodulators, either extracts from bacterial walls or hemisynthesis products, are also being studied at Roussel-Uclaf and Rhone-Poulenc.

Growth Hormones:* a Dwarf Market That Could Grow

Already in 1975, SANOFI got interested in peptidic hormones synthetized by animal cells. In 1979, using chemical synthesis, it managed to produce somatostatine, a hypothalamus peptide which inhibits the hypophysis secretion of growth hormone (GH). Simultaneously, it was studying anti-somatostatine antibodies which, blocking the inhibitor, could bring about an increase in GH secretion.

In 1980, SANOFI achieved the cloning and expression of human GH in mammal cells modified through genetic engineering. It has now reached the pilot production stage; clinical tests should start in 1985.

* Growth hormone was already produced by extraction from human hypophyses removed after death, and was used solely to treat hypophyseal dwarfism. Kabi Vitrum (Sweden) covered 60 percent of the world market, but this could provide treatment for only one out of every six cases of hypophyseal dwarfism. This is why we review the growth hormone (GH) as a "new product." (See BIOFUTUR No 4, June 1982, page 29).

As it was involved in GH production, SANOFI could not disinterest itself from GRF, the hypothalamus neuropeptide controlling the secretion of GH by the hypophysis.* Therefore, when the Salk Institute achieved sequencing of this peptide in 1982, SANOFI was of course interested. A collaboration has already been established between French physicians and Prof R. Guillemin (Prof Guillemin was the first to obtain a GRF sequence from the pancreatic tumor of a sick woman in Lyons). Very soon, SANOFI started producing GRF by liquid-phase chemical synthesis, and clinical tests were started already in 1984. The first stage of these tests is now being completed and could lead, in 1985, to the commercialization of a GRF diagnostic test (an in-vivo test making it possible to diagnose the origins of the GH deficit). Simultaneously, SANOFI is studying various possibilities to produce GRF through genetic recombination. The two production methods, chemical synthesis and genetic engineering, are being explored. For the time being, it is difficult to predict which method will yield the best results. In addition, GRF analogs, which are shorter and easier to synthetize chemically, might be equally effective.

It will take considerable clinical experience to determine, in the next few years, the respective advantages of GH and GRF. The market for growth hormones will quite probably grow beyond the treatment of dwarfism, which after all is rather limited. Growth hormones could be used in the treatment of premature babies and constitutionally small children, burns (clinical testing of GRF on burns is about to start), fractures and osteoporosis, obesity and undernutrition... In addition, growth hormones could also be used in veterinary medicine; they could replace anabolic steroids.

As can be imagined, these prospects have aroused strong competition, especially on the part of Genentech, which allied itself to Kabi. In spite of all, France seems to be in a good position.

Monoclonal Antibodies

The production of monoclonal antibodies through the method of hybridomes, or through transformation of plasmocytes with the Epstein-Barr virus, has already found many applications in the field of diagnosis. It could also find other important applications, especially in the field of cancer: diagnostic imagery and treatment.

The Clin-Midy Research Center (SANOFI), specialized in immunology research, is developing a research program on "armed antibodies" or immunotoxins for the treatment of cancer. Specific antibodies of tumor cells are linked to the A chain of ricine, which is toxic for the cells that have fixed the antibody. Clin-Midy is producing enough immunotoxin for clinical tests involving in-vitro treatment of cancer patients' bone marrow.

Research Structures

It is difficult to evaluate accurately how many people are included in research teams working on the health applications of biotechnologies, for these

* See BIOFUTUR No 24, May 1984, page 37.

teams are often integrated, at least in part, into the overall research system of companies and subsidiaries. They are also multisectorial, as they work in various branches (health, agronomy, industry).

Transgene, Specialized in Genetic Engineering

Created in 1980 after a meeting between two scientists (Pierre Chambon, professor at the Strasbourg University, and Philippe Kourilsky (in charge of the Gene Molecular Biology unit at the Pasteur Institute in Paris) and a banker (Robert Lattes, then Director of Surveys and Forecasts at Paribas), Transgene is the only existing French genetic engineering company.

The company now employs some 70 people, including 30 scientists and 30 technicians. Transgene's activity depends essentially on research contracts signed with industrial partners. Most of these contracts were signed with French industries; negotiations are currently taking place with various European, U.S. and Japanese companies. They should be concluded soon.

Rhone-Poulenc, a Subsidiary Specialized in Genetic Engineering

In 1980, Rhone-Poulenc Health created a subsidiary specialized in genetic engineering, Genetica... It now employs 25 people, including 10 researchers. This number should soon be increased to 16 or 18.

Research on fermentations are carried out at the Vitry Technical Research Center; they employ some 100 people.

Elf and SANOFI, a Subsidiary Specialized in Biotechnologies

Research at SANOFI is geared to eight major research orientations and services shared by these research lines.

Quite recently, a biotechnology research center was created at Labege, south of Toulouse. A subsidiary of SNEA [National Elf-Aquitaine Company] (50 percent) and SANOFI (50 percent), it concentrates and coordinates the group's research and development resources in this field. The Labege EBR [expansion unknown] center has been operational since the beginning of the year and already employs 120 people, one third of whom in genetic engineering. The center also includes a fermentation pilot plant. To this potential should be added the Clin-Midy Research Center in Montpellier, which is working on cell fusion methods (hybridomes) and on the production of monoclonal antibodies through cell culture and scites [as published].

Merieux, a Full Commitment

The Merieux Institute is "naturally" and totally involved in biotechnologies, as 35 percent of its activity is devoted to the production of vaccines and 65 percent to the production of blood derivatives.

The research center of the Merieux Institute at Marcy l'Etoile regroups about 100 people. It is difficult to estimate the proportion of research devoted

to genetic engineering. It would appear to be rather small, as the Institute is said to focus its efforts mainly on development, research on genetic engineering being provided by outside collaborations.

As a result of the agreement signed on 11 September 1984 by Rhone-Poulenc and SANOFI, modyfing the status of serum and vaccine operations at the Pasteur Production Institute, Rhone-Poulenc and the Merieux Institute are collaborating with the Pasteur Institute for the implementation of research, especially in the field of vaccines.

Roussel-Uclaf, Integration of Genetic Engineering

In 1980, Roussel-Uclaf equipped itself with a genetic engineering unit which now includes close to 60 people. This unit is integrated in the Romainville Research Center, near Paris, the central core of the group's research. Projects range from products for human therapeutics to products for agro-veterinary applications.

Roussel-Uclaf's research potential in biotechnologies regroups about 100 people.

Type of Research

French or International?

The biotechnological competition is taking place at international level. Research teams must achieve a high level. They are recruited internationally. Job offers for French biotechnology research centers, therefore, are published in journals with an international audience. To mention only one example, the 30 Transgene researchers who have a doctorate (or a PhD) are citizens of 10 different countries!

To attract high-level foreign researchers, it must be possible to make them interesting offers and provide them adequate resources. Are French companies in a position to acquire the best foreign researchers? They say they are.

The research carried out by the French industry in the field of health, as well as public research, is generally of high quality and, at least in certain fields, can rival with the best foreign laboratories. But the size and number of the teams are small. In the United States, Transgene would rank about tenth.

Internal or Outside Research?

French companies, like their foreign competitors, are carrying out research under contracts with public and private, French and foreign research centers. Nevertheless, a policy of collaboration implies the need for a high-level research core within the company, if only to define and assess this collaboration.

In several companies, people emphasize the importance of the "international friendship network" which is carefully nurtured, thus making it possible to secure the best collaborations, and information and solicitation priorities whenever something interesting is discovered!

From Scientific to Industrial Success

The road from laboratory production of a few micrograms of a product to its marketing is long and strewn with obstacles. To encourage their shareholders, U.S. genetic engineering companies put forward their success in gene cloning and expression. But, as P.H. Schmelck, in charge of biotechnologies at the Labege EBR center, pointed out: "A scientific success is useless unless it can be integrated in the industrial system." To be competitive, it is also necessary to master a whole series of methods and own the production plant. Then, the safety of the product and its biological and therapeutic efficiency must be demonstrated, marketing authorizations must be obtained for all countries, the market must be conquered and, finally, production must become profitable.

France started late, but the game is being played throughout these various stages. Is there one stage on which France could rely to make up for the time lost?

Although groups such as Roussel-Uclaf, Rhone-Poulenc and the Merieux Institute already possess a good experience in the field of fermentation and/or cell culture, are their capacities better than those of their competitors? As for the commercial establishment of French firms abroad, it is not always very strong.

The example of growth hormones illustrates the complexity of the problems encountered. Genentech (under an agreement with the Swedish company Kabi) got a headstart in the race to produce the human growth hormone. In 1979, it announced that it had achieved expression of the gene in E. coli. Production of the hormone started at the pilot stage and, by mid-1982, reached industrial level. Kabi then hoped to obtain rapidly the marketing authorizations required. But the hormone produced by E. coli includes an additional methionine which, in theory, could induce the formation of antibodies. Clinical tests actually showed that antibodies had appeared in some of the subjects treated, although this did not seem to have any clinical implications or to affect therapeutic efficiency. Yet, this problem delayed the marketing authorizations. Kabi hopes to obtain in 1985 the authorization to market this growth hormone in Sweden and the FRG. As for the Food and Drug Administration, which alone can open the U.S. market, it has not yet given its agreement.

Even if the growth hormone produced by E. coli is marketed before that produced by animal cells (the method chosen by SANOFI), the latter may prove of higher quality and conquer the market. And the market could also be reduced, due to the emergence of GRF and later on, maybe, of somatomedine C.

Actually, the game may well be played as a series of punctual rounds, product by product, or by families of products. And the most interesting products may not have been discovered yet. Will they supersede the first realizations of biotechnologies? Already, interleukine 2 appears to some to be more interesting and more promising than interferon.

Problems to Overcome

Can France still gain prominence on the biotechnology market? Finding new products that are efficient and original, carrying a consistent research policy at French level, or even at European level, all these are problems that must be overcome.

The French industry is well aware of this, as is illustrated by the recent agreements between IPP [expansion unknown] and the Merieux Institute on the one hand and, on the other hand, by SANOFI and Roussel-Uclaf, on interleukine 2.

The Diagnosis Industry

Monoclonal antibodies have found their main current application in diagnosis products. They will progressively replace immunoserums by solving cross-reaction problems, thus making possible the development of new tests.

Technical problems involve mainly the marking of the antibodies required to evidence the antibody-antigen interlocking.

Several French companies and organizations are interested in the technology and production of monoclonal antibodies for diagnostic purposes: BioMerieux, which covers half the sales of French companies on the French diagnosis market; CNTS whose success with blood-typing kits we mentioned; Oris, a CEA subsidiary which controls over half the French market for radioimmunological reagents; Immunotech, created in 1981 to commercialize the results of the INSERM's basic immunology research; SANOFI/IFF, Api System, Biosys, etc.

International competition in this field is fierce. The French market for diagnosis products is widely penetrated by foreign companies.

It is by innovating in sophisticated reagents, getting involved in the study of new marking systems (bioluminescence, latex test) that the French industry could start the reconquest of the domestic market.

DNA probes can look forward to considerable development for diagnostic purposes. In this case too, the main problem is marking. We should note that the Pasteur Institute was the first to patent an enzymatic marking system for DNA.

Sources of Financing

Paris BIOFUTUR in French Dec 84 pp 137-140

[Article by Helene Constanty and Laurent Faibis: "Biotechnologies and Financing: Looking for a French Model"]

[Excerpts] Fascinated by the dynamism of U.S. venture capital, France is still looking for financing methods that would enable advanced technologies, in particular biotechnologies, to expand beyond the limits of a small club of large government-supported companies. It is

felt, indeed, that life technologies are poorly suited to massive financial efforts focussing on a few large projects; the multiplicity of disciplines, technologies and possible applications as well as the fragmentation of the markets are as many imperatives for a broad decentralization of initiatives.

Twelve years after the first financial investment companies (SFI) were set up, the results achieved by venture capital in biotechnologies appear quite modest; they are said to have contributed aroud FF 10 million to biotechnology-related companies. Certainly, all equity capital contributions do not necessarily transit through financial investment companies. Financial institutions such as Paribas, the Financial Company, the Union for Surveys and Investments (Agricultural Credit Bank), BANEXI [Industrial Expansion Bank], CCF [French Commercial Credit Bank] and a few others are also likely to contribute their support. Yet, in spite of this relative abundance of possible financing, the long-awaited creation of companies specialized in biotechnologies did not take place.

For a Few Dollars More

At Paribas: certainly, this large commercial bank can boast having initiated one of the largest French small-biotechnology-companies, Transgene, in which it invested FF 15 million. But it is FF 80 million that the financiers in Rue d'Antin contributed to the U.S. company Centocor. Two venture capital funds also complement Paribas's arsenal abroad: Paribasven in the United States ($30 million) and Paribasven Japan ($20 million) together have taken some 12 participations in various companies on both sides of the Pacific.

Are the United States the promised land of venture capital and biotechnologies? We could mention many examples that confirm this, from Elf Technologies (the U.S. base of Inovelf, the Elf-Aquitaine subsidiary) to Agritech Partners (consisting of several manufacturers regrouped around the Agricultural Credit Bank).

But Where Have All the Projects Gone?

Should we put French financiers in the dock for "non-assistance to biotechnologies in danger," considering how marvellously they manage when the rationale is in dollars? Yet, the case for the defense appears to be supported by a tight alibi: the lack of viable projects.

First proof: to finance projects, projects must first exist, the potential investors concerned are unanimous to declare. Several of them claim to have contributed capital to anything that was worth financing. The proof, one of them said, is that we are all involved in the same ventures. And, truly, it is striking to see what a small world is that of the people responsible for providing equity capital to specialized biotechnology companies, a world that can meet regularly at the board meetings of the few companies created in France.

Another argument: it is difficult to find genuine managers capable of "piloting the ship." A financier accused of favoring U.S. biotechnologies tells

the following anecdote: "Once, in my office, I met with a very competent French researcher who had come to offer to create a company 'like Genentech' to develop industrially the results of his research. Without reading his documents, I first asked him if he had an idea of the size of the market involved: my technology is revolutionary, he answered, pointing to the thick file. I again ventured to ask him to outline a business plan: he left screaming." This example is, of course, a caricature, but it is rather significant of a state of mind that is too common in France.

Gathering the competent people required for the creation of an advanced technology company: this is an obstacle that appears difficult to overcome. According to Jean Fonteneau of Sofinnova, "the ideal is the troika that is frequently found in the United States: one technician, one marketing man and one financier. In France, there is too often just one person to fight for a project." Another banker stated: "The French have a very patrimonial view of business. It is difficult to persuade a potential creator that it might be helpful to enter into a partnership with people whose competence would complement his, considering that he will never have the means to hire a high-level manager from another company."

At any rate, we should not forget that the role of the venture capitalist is not to finance research but industrial and commercial development. The market for manufacturers eager to innovate is much narrower in France and, at international level, competition is fierce, to say the least.

If it is difficult to find projects, it is also difficult to get out: is it necessary to point out once again that the objective of the venture capitalist is to make a profit through the capital gains realized by getting out of the company as soon as it reaches its cruising speed. Getting out is still much of a problem in France, due to the narrow scope of the stock market. This question of "getting out" is among those that inhibit the most strongly any desires to take risks. Everybody is expecting much from the second stock exchange, created early in 1983. But, for the time being, only one company involved in biotechnologies has found its place there: the Orsan company, which is very much of a security blanket.

The second possibility to "get out" of a venture is to resell it to a larger manufacturer. But the market for this is still narrower; potential buyers of small biotechnology companies are not exactly beating a path to the doors of financial investment companies. Lacking competition, selling prices are ridiculously low.

New Financing Tools

Cost of research, management inadequacy, lack of markets, difficulty in getting out, there are many clouds in the financial sky of biotechnologies in France. Observing that financial investment companies may not be the best possible way to finance the new technologies, in particular biotechnologies, French venture capitalists have taken an active part in the creation of new tools capable of providing them with equity capital. In the past two years, government initiatives in this respect have multiplied: creation of the second stock market and of venture capital mutual funds (FCPR) in 1983, law on the development of economic initiative in 1984.

During 1983, the first venture capital mutual funds were created as a result of the law on savings of 3 January 1983, whose goal was to channel savings to the industry. Since May 1983, some 20 FCPR management companies have been approved by the COB (Stock Exchange Operation Commission) and over 15 funds are now active.

Venture capital mutual funds now appear to constitute direct competitors for financial investment companies; since 1982, no new financial investment company has been created, whereas most banks have shown their interest for venture capital mutual funds. Thus, although the Industrial Development Institute had contemplated creating a new financial investment company oriented in particular toward biotechnologies, it finally decided on a venture capital mutual fund.

According to Jean Laurent-Bellue of the Industrial Development Institute, some of the reasons for this choice were "greater flexibility, limited time period with the possibility to liquidate and cash capital gains more easily."

Uncle Sam Prefers Venture Capital Mutual Funds

A token of the interest of the new tool represented by venture capital mutual funds, the first fund was created in June 1983 by Alan Patricof Associates, the French subsidiary of one of the U.S. leaders in venture capital, under the name APA Venture Capital. Its objective is to gather FF 100 million by 1984 to take participations exclusively in companies not listed on the stock exchange, at the rate of four to five participations per year.

As Maurice Tchenio, the fund manager, indicated: "We want to engage in American-type venture capital investments; the venture capital mutual fund formula is only the legal framework that will authorize us to operate in France."

Other U.S. venture capitalists are said to be ready to take the step that will bring them into France (TA Associates, Technoventure, Citibank, etc.). If they still hesitate, it is because there is still some uncertainty as to the manner in which the fund managers will be taxed when the fund is liquidated; will the 20-percent bonus that the manager is entitled to receive be considered as capital gains, subject to a 15-percent tax, or as remuneration for services performed, subject then to a 70-percent tax?

Although not all problems have been solved yet, 1984 may well herald the start of a new stage for biotechnologies, thanks to the law on the development of economic initiative, i.e. the Delors law of July 1984. Actually, this law makes it possible to set up R&D limited partnerships on the American model; an additional instrument designed to fill the gaps left by financial investment companies as far as research financing is concerned.

R&D Limited Partnerships to Finance Research

In this system, the capital contributor contributes to the financing of a well-defined research project within a company. He is remunerated by

royalties once research has led to material applications, i.e. if the project succeeds. The formula seems better adapted than that of financial investment companies to the present needs of biotechnology companies when it comes to mobilizing considerable research means.

"In 1983, R&D limited partnerships were able to collect about $1 billion in the United States, including $250-300 million for biotechnologies," we were told by Dominique Peninon of the Financial Comapny, whose economic interest group Innovation Financial Company was created, among other things, to make it easier to arrange for setups of this type between French and American companies.

In France, the lack of liaison between the academic world, the world of research and companies is one of the weaknesses most commonly denounced on both sides. Of course, there is some collaboration between research organizations and manufacturers; in the field of biotechnologies, many research contracts are signed between companies and, for instance, the INRA [National Institute for Agronomical Research]. But the risk is greater and capital mobilization more chancy when a researcher wants to develop a project within the company itself.

This is why the Delors law provides that an outside financier, in that case a financial investment company, could share the risk. "Financial investment companies will have to initiate and provide a framework for projects of partnership between companies and researchers, by participating in the technical and commercial implementation of researchers' work."* Materially, the new law is reflected in depreciation rules more favorable than at present for companies underwriting the stock of a financial investment company, provided that part of the funds is used to finance research or research-development programs. Already, many R&D limited partnership projects are being considered by financial investment companies and other financial organizations (Sofinnova, Innovation Financial Company, etc.).

At Last, French-Type Stock Options

The second facet of the law on economic initiative is the association of employees to the performance and future of their company. Two measures could considerably alter the economic environment of biotechnologies: stock options and leverage management buy out (LMBO), in other words options to buy stock and the acquisition of corporate stock by a company's employees.

Until now, the stock option system was touted as one of the essential "recipes" of U.S. venture capital. It makes it possible to reserve a certain proportion of the company stock for the employes at the time of creation of the company, and the option to purchase can be exercised a few years later. The Delors law contains several improvements of the system, which should lead to widespread acceptance of stock options. Options to purchase shares could cover one third of the company's stock (compared with 5 percent previously).

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* According to Jacques Delors's speech at the Senate on 20 June 1984. published in NOTES BLEUES No 183 of July 1984.

This acquisition can be made at a price more favorable than the market price, the price differential being exempt from income tax provided that the stock is held for at least three years (compared with five years under the 1970 law).

Venture capitalists agree that the stock option system is a powerful factor in motivating corporate cadres, as the exercise of the option is linked to a result parameter set in advance. High-level researchers are few in the small world of biotechnologies. Giving them an opportunity to acquire stock in the company is to a certain extent a way of cutting the ground from under head-hunters' feet.

Long before the new law was adopted, biotechnolgies were a good ground for experiments with stock options. The management of Immunotech thus benefited from an option to purchase 10 percent of the company stock at a preferential price, subject to certain preset commitments as to results.

Tax Credit to Encourage Leverage Management Buy-Out

The last "tool" provided by the new law is leverage management buy-out, i.e. the progressive repurchase of corporate stock by the company's employees.

A "major step forward," according to Mr de Victor of Sofinnova, "and a step that could lead to quite a few biotechnology projects." Already, Sofinnova is studying the case of the purchase of a large company's division by its cadres.

The push in the right direction given by the law of July 1984 is the result of a tax credit working as follows: the workers of company A create a new company B in which they hold at least 50 percent of the voting rights. Company B repurchases, for instance, 60 percent of company A's stock. If A has paid 100 in corporate taxes, B will benefit from a tax credit of 60.

The role of the venture capitalist is to contribute most of the funds required while allowing the management to own a majority interest in the company. The operation is also made easier by the fact that employees now have the possibility of deducting from their taxable income the interest on loans contracted to create the new company.

Leverage management buy-out is especially popular in Great-Britain, where it was at the origin of the creation of over 350 companies in 1983. In France, bankers soon expressed their interest. Three venture capital mutual funds have already been created in 1984 to encourage company transfers: Cofidic by Paribas and the North Credit Bank; Capital Transfer (National Credit Bank, Indosuez, Private Industrial and Security Bank, and Charter House); and Team (National Credit Bank, Union of Paris Insurance Companies, and Sofinnova). It remains to be seen whether entrepreneurs will answer the call...

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BIOTECHNOLOGY

BIOCARB OF SWEDEN FUNDS HORMONE, AGRICULTURAL RESEARCH

Stockholm SVENSKA DAGBLADET in Swedish 13 Dec 84 p III

[Article by Carl-Ake Nilsson]

[Text] Lund--"Nils Horjel has been a pioneer. Ideon arrived on the scene at exactly the right moment." This was stated by financier Erik Penser when the Ideon company BioCarb presented its latest research and business project in Lund last Wednesday.

BioCarb was the first company that moved into the research village of Ideon in Lund. It has expanded rapidly and now has a unique base for its operations. Biologically active carbohydrates are an area of research that has been almost totally neglected. Five totally new products for blood-typing have already been released on the world market and are selling well. The exceptions are the United States and Japan, where the products are subject to special registration. This will be complete in the near future.

In addition, BioCarb has three other products for blood-typing that soon will be ready for marketing. The company was formed by four researchers in the fields of chemistry, biochemistry, and biology. They are Prof Alf Lindberg of the Karolinska Institute, Prof Arne Lundblad of the Lund Hospital, Prof Per-Anders Mardh of Uppsala University, and Prof Sigfrid Svensson of Lund University. Together, they own 60 percent of the company. Erik Penser owns 20 percent, Anders Wall owns 5 percent, and the rest is owned by the company's executive vice-president Per Sjoberg, company personnel, and four consultants who have been hired to handle marketing and contacts with other companies.

BioCarb is now embarking on two totally new products. The first is a 3-year research project together with Perstorpskoncernen, in which a total of 2.3 million kronor will be invested to develop a purification method for hormones, enzymes, and toxins (toxic proteins). The second project, which is still in the discussion stage, will be carried out in cooperation with Ewos of the Alfa-Laval group. It is estimated that this project will cost 6 million kronor. Its purpose is to develop an alternative to antibiotic treatment of udder infections in milk cows. This is a worldwide problem. Udder infections now cost 20 billion kronor annually in production losses on a global basis.

Erik Penser, a member of the BioCarb board, believes that the company has some interesting future prospects. He sees his board membership at Bofors, Leo, and Gambro as advantageous to BioCarb in the long run. He also sees the entire Ideon concept as extremely important and significant to the region.

"I am pleased to be involved in my home town. When BioCarb was looking for investers, I thought it sounded exciting, even though I did not fully understand everything," Erik Penser told SVENSKA DAGBLADET.

In addition to BioCarb, he is also on the Ideon board and has placed his name on the subscription list for shares in the real estate company Ideon AB and Ideon-Venture AB, which will soon join the Securities Register Center.

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BIOTECHNOLOGY

BRIEFS

MICROBES RETAIN MOISTURE--Nordic microbes will now turn sterile deserts into fertile fields. Biotech Inc has developed a method for doing this which is now under study by the Nordic department for development aid. The method calls for spraying microbes on the desert following the planting of fast-growing trees and bushes. The microbes form a viscous layer that prevents the ground from drying out. It normally takes only days or hours for the desert to dry out after even the hardest rain. [Text] [Stockholm SVENSKA DAGBLADET in Swedish 8 Feb 85 p V] 9992

CSO: 3698/294

CIVIL AVIATION

A 320 TO HAVE COMBINED AUTOMATIC PILOT, FLIGHT CONTROL SYSTEM

Paris ELECTRONIQUES ACTUALITES in French 14 Dec 84 p 17

[Article by H. Prandenc: "SFENA [French Aerial Navagation Systems Co.] and Sperry Combine Automatic Pilot and Flight Control on the A 320"]

> [Text] An innovative machine in more ways than one, the A 320 will be the first airliner equipped with a combined automatic pilot and flight control system [FMGS], development of which has been entrusted to the SFENA-Sperry tandem. SFENA also is participating in this project by producing electronic flight controls along with Thompson-CSF and has answered calls for bids on other systems including the gyrolaser inertial unit.

As we indicated in our 16 November edition, Airbus Industrie has chosen the French systems manufacturer SFENA, a Sperry associate, to furnish a system combining flight control and automatic pilot for the new Airbus A 320. The two companies are equal partners in this developmental project and a Sperry team, you will recall, will direct this project from the SFENA facilities at Velizy near Paris. SFENA is the titular contractor. Also, to head off the criticisms which have plagued preceding Airbus projects, the German aeronautical industry is to perform at least 30 percent of the work on the A 320 FMGS through its companies of Bodenseewerk-Geraetetechnik and Apparatbau-Gauting. It is clear, at least for this civil project, that Europeans are attempting to cooperate equitably. This behavior is dictated by the absolute necessity to meet the challenges of research and development investments and to reduce commercial risks.

Drawbacks of Integrated Systems

The FMGS will benefit the A 320 by a weight advantage estimated at from 20 to 30 kg as well as a lower purchase price for this system compared to that of separate automatic pilot and flight control systems. On the flip side of the coin, integration of the two systems into one will work against the systems manufacturers who are reduced to hoping for strong commercial success for the planned aircraft. In fact, at SFENA it is pointed out that this integration will lead to a reduction from 17 computers on board the A 300 to 6 on the A 310 down to 4 on the A 320.

The result is that the French company, as well as the other systems manufacturers, will be commanding an increasingly smaller share of the overall systems market for hardware dedicated to one specific function.

For the A 320 FMGS, SFENA will use the INTEL 8286 microprocessor for calculations related to final approach guidance and automatic landing. For this purpose, the French company has at its disposal a real erector set of hardware and software which it will assemble as soon as it determines computer specifications and has developed the software. Navagation and performance calculations will be carried out by the Sperry SDP 175-3 system with its software linked to bubble memories. Initial production deliveries of the FMGS are projected for the beginning of 1987.

Remember that SFENA and Thompson-CSF will develop the electronic flight controls for the A 320. These will use computers to process information delivered through the pilot ministick. They are thus appearing on civil aircraft in response to a new concept which separates this function from the piloting function where the computer will be dedicated to piloting and flight control. Computers for flight control must be highly reliable and require redundancy. In the case of the A 320, this redundancy will be provided by the ELAC computer from Thompson-CSF linked to the SEC from SFENA and will make up the core of the system. On future European civil projects, in SFENA's opinion, much more significance will be attached to electronic flight controls, and this justified the company's involvement with the A 320.

Central Gyrolaser Unit

Among other systems on the 150-passenger European carrier, SFENA has proposed to the Airbus Industrie consortium the creation of a mass measurement and centering system whose data will be used by the FMGS, a system the firm is also promoting in the United States. The systems supplier has also answered the call for bids on the on-board integrated testing system. Likewise, SFENA has submitted a proposal to supply an inertial reference system based on the company's 33 cm gyrolaser. The European consortium's choice for this system is supposed to be made late in 1984.

This gyrolaser, equivalent to that of the American company Honeywell, will equip, redundant to that of the English firm Ferranti, the systems component of the Ariane 4 rocket. Also, under a development contract for a military plane, SFENA is building the prototype of a central unit which will fly in 1986. A mock-up already flew last year. Remember that SFENA has a gyrolaser production capacity of 100 units per month. This figure seems realistic considering the potential market represented by applications of the 12 cm gyrolaser, which is the object of a cooperative bid with Crouzet to outfit the prospective Franco-German military helicopter. In addition, 13 units of a similar system have been ordered for flight tests of the ANS-2 missile, the successor to the Exocet which Aerospatiale and MBB are developing.

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ERRATUM: This article is republished from JPRS-WST-85-005 of 5 February 1985, pp 30-31, to correct certain translation terms.

COMPUTERS

DATAFLOW MACHINE RESEARCH PRESENTED AT FRENCH CONFERENCE

Paris MINIS ET MICROS in French 22 Oct 84 p 25

[Article: "Data Processing Convention: Architectures of the Future and Dialogue Between Man and Machine"]

[Excerpt] The Data Processing Convention which, like every year, precedes the SICOB [Exposition of Office and Business Supply Industries and Office Organization] covered many points for reflection in all areas of the profession. As we could not "cover" the exposition fully, we have been interested more particularly in new architectures and in man-machine dialogue.

Dataflow Machines in the 1990's

Mrs Francois Andre described the research carried out on systolic machines at IRISA [Institute for Research in Data Processing and Random Systems] in Rennes [Brittany]. A systolic machine is composed of a network of data processors communicating with each other and in which the data is propagated and modified. A processor receives a data entry, processes it, and distributes to its neighboring processors the results which will serve as a basis for new calculations.

Each of these processors has a simple structure. A systolic machine is therefore an assemblage of many simple processors, whereas a Von Neuman machine consists of a single, complex processor. The propagation of data in the processors takes place under the influence of a synchronous cadence. This makes one think of the circulation of blood: hence the name, systolic machine.

Thanks to a tool developed at IRISA, Diastol (Interactive Sketch of Systolic Architecture), many simulations have been tested to determine the area for the use of such machines. This area of use is more extensive than may appear to be the case, when you tackle these investigations manually: image processing, graph computation, signal processing (e.g. Fourier transform and products of convolution).

The object of using Diastol is to automatically define a systolic architecture, on the basis of processing equations, which should first be reformulated in a uniform, recurrent form (that is, bringing in the computations made by other processors). Diastol determines the number, the nature and the cadence

of the processors. It has also shown the difficulty of initializing the processors before the machine is fully in operation.

A word recognition circuit has been designed with a systolic machine.

However, it appeared that the synchronous control of many processors could pose a problem because of the propagation of clock signals. Abandoning this simple but rigid sequencing is a possibility, to contemplate introducing a little communications procedure between the processors.

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COMPUTERS

FRENCH WORK TOWARD 'FLEXIBLE SOFTWARE WORKSHOPS'

Paris LE NOUVEL AUTOMATISEME in French Oct 84 pp 22-25

[Text] The software workshop of the future, composed of specialized machine tools--data base machines, language machines, object machines--and capable of generating software which can be used on some target machine are coming up on the horizon. Already some people are even dreaming of a flexible software workshop. This flexibility will be necessary to adapt such a software workshop to the great diversity of situations and of production in the field of program development. The Concerto projects, directed by the CNET [National Center for Technological Studies], and the Emeraude [Emerald] national project directed by Bull, SYSECA and EUROSOFT, provide an early indication of what these flexible workshops will be like.

The flexible software workshops naturally involve automation specialists and factory automation specialists who, for their part, develop such systems as LMAC, which is capable of generating real time systems for factory automation, or the PTA project (automation engineer's work station)--drawn up by PSA, the RNVR and ADEPA.

The fact is that old-fashioned programming, with a pencil and a piece of paper, is now old hat. As in the case of mechanics, CAD applied to the programming will make it possible to work more efficiently and to turn out products of consistent quality. It was at the Second Congress of Software Engineering, organized by AFCET and which had a software exposition organized by the ADI and the ANL (National Software Association), that an overall view and a display of the state of the art were shown, concerning methods and tools for automating programming processes.

However, in reality software engineering activity begins with defining the problem.

Specifications

This involves carefully defining the problem raised by the customer. It should be admitted that many difficulties encountered in subsequent stages

(development and maintenance of the software) could have been avoided if the problem had previously been defined more precisely. This is what has led to the development of many languages for developing the specifications of a problem.

Good specifications are the basis of all development. To be good, specifications must be clear, unambiguous, complete, readable and open to change.

To achieve these characteristics, one should use an automatic software specification tool, based on a recognized specification method. Among the specification methods most commonly used throughout the world we might mention the SADT system (Structured Analysis and Design Technics) produced by the American company Softech and by the Institute of Software Engineering (IGL) in Paris, as well as IDEFO. The IGL has developed "Specif," an automatic system for assisting the specification process, which supports the SADT and IDEFO methods.

Designing a Solution

The crucial point in program development is the passage (or transition) from the phase of analyzing a problem (specification) to the phase of designing a solution. The traditional method only makes use of the experience of those designing the solution and assumes that we start from zero with each new study.

The method that will be used in the future, and which is entirely automatic, will make it possible to move from the analysis of a problem to designing a solution. That will only be possible when we have "expert" systems of design which are sufficiently powerful to encompass the intelligence and the experience of software designers. At present we have not reached that stage. However, we can stay midway between these two extremes, for example, by using the methods of analysis and design described by Michel Lissandre, director of methods and training at the Institute of Software Engineering (IGL). These methods use SADT and MACH (Hierarchical Method of Analysis Design) software.

A similar solution has been described by F. Schlienger and J. Corbin. It makes it possible to develop a program whose structure corresponds automatically to the specification structure. For this purpose it simultaneously manages the specification and editing of the program in a closely interleaved way. That process does not require a tedious period of training. Further, errors of syntax are automatically set aside, both in the specifications as well as in the program. Oversights and input typing errors are closely checked.

Michel Beaudouin-Lafon and Christian Gresse, of LRI in Paris XI [11th District] at Orsay, have developed the idea of presenting the data and the programs on a monitoring screen, which increases the simplicity and the speed of the process of design. This is still only experimental and has the sole purpose of proving the feasibility of this idea, which will considerably improve the industrial production of software. This method is called "Design Assisted on the Basis of Types" (CATY).

Measurement of Program Quality

This is a very broad question, since the elements involved in it are innumerable. In English this is called "Software Metrics." In French this is given several names: "controle de qualite" [quality control], "metrologie" [metrology], or "logimetrie" [logimetrics], the latter of which seems the best to us. There is an evident need for this, which justified the fact that the last 2 days of the Congress of Software Engineering were devoted to this aspect. The fairly clear title given to this phase was "Quantitative Approaches in Software Engineering." The objective of this seminar was to bring us up to date on the measurable elements of software and to evaluate the effectiveness of the procedures for design and development, as well as the human and material resources necessary for such development, and finally to follow the progression of some software projects.

The measurement of program quality makes it possible to choose, for example, among several software packages now on the market, which resolve the same problem.

Serge Bouchy (from SOPRA) told us: "You have to go into the field of the practices which you should evaluate, check and qualify in order to know whether this kind of service is really worth providing and whether its cost is appropriate."

On the other hand Pierre Morliere remarked to us that: "In all the sciences and technical fields measurement is the heart of the matter. It makes it possible to verify assumptions. We reach the point of considering software as an object with properties which we can measure and no longer as an abstract or mathematical thing, an algorithm, an idea which we used to think could not be measured. We distribute certain kinds of software in millions of copies (video games; Visicalc--450,000 copies). The cost of measurement is therefore negligible."

Measurement of Complexity

Narayan C. Debnath, of the Department of Computer Science, Iowa State University, began his presentation as follows: "The measurement of software complexity plays an important role in forecasting the development cost of projects. This kind of measurement can be very valuable when it makes it possible to estimate the time required to develop software." If several forms of software resolve a given problem, it is advantageous to know which will be the quickest to solve it.

On the other hand, the number of errors in a program increases with its complexity. Otherwise stated, the reliability and the complexity of a program vary inversely. As a general principle you can thus predict which are the subordinate elements of a program with high risks of errors. (Contribution of R. Ferreol of CIMSA.)

Pierre Morliere presented us with another point of view: "At present we have many ways of making microprocessors go well beyond what they are currently

doing. The limiting factor is not the cost, since this will be reduced by broad commercial distribution of the microprocessors. Rather, the limiting factor is our capacity of knowing how to design very complex software in a very rational way and which works. Well adapted software tools must be developed.

"We should distinguish between intrinsic complexity (concerning the problem to be resolved) and the complexity of the product which satisfies this problem. Here are a few examples of complex problems: voice recognition, automatic reading of handwriting, automatic translation of computer languages of excellent quality, and robots. The tests become very complicated when they involve complex programs."

Regarding the translation of computer languages, we might note the presentation by INRIA (Domaine de Voluceau-Rocquencourt-Le Chesnay): "The application of high level tools for the development of an automatic translator of PASCAL into ADA." Thanks to these software tools, it only took 5 man-months to design and develop it.

Tests and Validation

The development of batteries of tests can also be helped by the use of appropriate software. In this connection Bernard Houssais (of IRISA at the University of Rennes) brought together about 100 errors found in the compilers of "Algol 68" and deduced a method for the systematic production of tests for compilers. This method can be generalized, either for the production of tests or for the analysis of errors. Its objective is limited to the simplest and most ordinary errors. The very systematic structure of these tests lends itself well to automation.

Test generators have been created to develop a test deck aimed at testing a certain type of software in all of its possibilities. This is a kind of automatic "made tailoring," like the production of clothing to individual measurements on an industrial scale [mesure industrielle]. However, there is an inevitable rate of breakdowns.

Most of the software testers agree on the many advantages provided by the execution of all instructions and all branches (or "paths") of a program. M.R. Woodward, of the Department of Computer Science of the University of Liverpool in Great Britain, has developed an algorithm making it possible to calculate the minimum number of "paths" which cover all of the instructions and branches, or all the "LCSAJ" or all pairs of "LCSAJ." "LCSAJ" means "Linear Code-Sequence-and Jump." This is an element of a path based on a text and which corresponds to a straight line sequence of text, through the command for starting operations, which can be sequential and can end with a jump in the program.

Reliability

The concluding day, 5 June, was devoted to the measurement of the reliability of software in all of its aspects.

Industrial software, which is generally of the "real time" type, requires high levels of quality in use and in maintenance. The INSA and APSIS are collaborating in the development of aids for the production of real time industrial software. They are aiming at achieving reliability from the phase of design of the software, using an aid provided for the development of the test plan, and a followup aid at the time of the tests.

The ratio between the number of errors found and the number of errors existing in a program is called the rate of coverage. The actual number of errors is evidently unknown. It is certain that the probability of finding a new error tends asymptotically toward zero when the number of errors already found and the number of tests performed increase. (Contribution of G. Morganti of Bell Systems.)

Two broad categories of approach in terms of the extent of coverage can be distinguished: "structural" tests and "functional" tests. An approach to the measurement of test coverage has been developed by the Electronique Serge Dassault Company, using the "IDAS" system.

An improvement in the measurement of text coverage has also been proposed by the Center for Studies and Research of IBM-France at La Gaude, near Nice. It uses new, dynamic indicators in place of the indicators of the quality used until now, which were static in character.

Richard N. Taylor, from the Department of Information and Computer Science of the University of California at Irvine, described techniques for the location of errors in real time application software. This software was often developed by a host machine and then recompiled for use by an object machine less powerful than the original host machine. Often the object machine has no software of its own, not even an operating system. Under these conditions it is difficult to check the quality of the software on the object machine. The author proposed a partial solution to this problem.

Project Management

Prediction models are presently being used by economic officials of companies and government services to prepare budgets, work out development strategies, and predict how long a project will last and the number of people required for it at various stages. The Oresys Company has developed FORECASTING models which have been tested on developments of French software.

CIMSA is using the "COCOMO" model (Cost Constructive Model) proposed by E.W. Boehm in the United States for the TRW Company. It is necessary to use corrective factors to take into account the differences between CIMSA and TRW.

P. Marland of the Center for Studies and Research of IBM-France in La Gaude, near Nice, has shown that the cost of work carried out on a computer with a response time of less than a second declines considerably if this work is done using interactive equipment. That is due to the fact that the time of the users is much more expensive than the time of the computer they are using.

Serge Bouchy of SOPRA told us: "All of that shows that we realize that data processing is not going to develop without consideration of the cost, because we are going through a period of economic change. We have to "tighten our belts" to produce better, more and cheaper. That will only be possible if we make progress in software engineering. That will probably reduce the present infatuation for the profession of computer scientist. This profession will become even more demanding. It will certainly not be an easy job, and it will not necessarily command fantastic prices."

The Concerto Project

Directed by the CNET [National Center for Technological Studies], Concerto is a proposed, advanced type of flexible workshop. The equipment of the workshop is based on an SM90 computer and a UNIX operating system. The core of the system used in the workshop is on the basis of ULYSSE (an object language in the small talk style based on LELISP and which offers structural operators and synchronization between coders in separate places). The overall structure is made up of an operating system which develops and transforms the software material; a control system which can observe and act on the operating system, giving it commands; and an information system making it possible for the two preceding elements to interact with the workshop on a permanent basis. The workshop as a whole is designed from a knowledge base defined with the F1 formalism (relation of entity and logical computation model) which determines the rules appropriate to the operating organizations. The objective as of the end of 1984 is to have a system capable of creating programs in PASCAL with an interpreter and debugger and generation of corresponding multitarget codes for the 68000 and LSI-II. Subsequently, it is planned to develop a specification environment.

Exhibitions of Software Exposition

Automatic Translator--PASCAL ADA-INRIA (Voluceau)

Portable Equipment for the Management of Cathode Ray Tubes--EDF (Clamart)

System To Assist in Cathode Ray Tube Management (Revė 22)--Crin (Vandoeuvre)

Integrated Software Workshop--IPI (Paris)

Prototype SSP Software Engineering Workshop; Specification: Automatic Equipment To Assist in Specification; Qualimeter-C; Program Quality Analyzer--IGL (Paris)

Pallas-Steria Software Engineering Workshop (Velizy)

Software Life Cycle Model SLIM-P. A. Computers and Telecom (London)

ADELE Program Base--IMAG (Grenoble)

Software Reliability Evaluation Workshop: Complexity Analysis Equipment--OGL (Toulouse)

LMAC Software Development System for Factory Automation--Information Laboratory, University of Nice and Besancon μS Robotics

Concerto Information System--CNET/CERT/CETE (Lannion)

SPRAC-LF: Expression and Management of Algorithm Specification and Representation--ONERA, Cert. Deri (Toulouse)

Experiments With Generic Programming in LPG--IFIA/IMAG (38402) [Postal Address]

SOPIADOC--LISH/CNRS Document Management Interface (Marseille)

Model of Management System for Versions Using Logical Programming (Foll. Prolog)--CRISS (Grenoble)

Caty-Asspegique-Petripote-Spada--University of Paris-South (Orsay)

Microcomputer Books and Software--Addison-Wesley (Amsterdam)

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FACTORY AUTOMATION

BOSCH OF FRG DEVELOPS ASSEMBLY ROBOT WITH BMFT FUNDS

Duesseldorf VDI NACHRICHTEN in German 12 Oct 84 p 1

[Excerpts] More and more large corporations are trying to get their piece of the pie on the huge market of robot technology, now that Bosch has also gotten on the band wagon and presented a new assembly robot in its Stuttgart headquarters on 3 October. Its construction is modeled on the Japanese "Scara" type, of which at present already about 7,000 per year are manufactured in more than 20 companies. It is chiefly for use in assembly, a sector in which Bosch feels particularly competent. As we know, the company is an experienced manufacturer of assembly technology, whether ergonomically constructed manual facilities or fully automated systems made up of robot modules. On the other hand, Bosch is equally a large-scale user of assembly technologies, and one-half of the assembly systems produced at this time are earmarked for company use. At least 10 to 20% of the new assembly robots will also remain in company plants; overall production in the next years will be in the three digit range according to Rainer Hahn, engineer, head of the Bosch division Industrial Equipment.

Peter Drexel, the head of development and construction for machine-building and assembly technology in the Bosch Industrial Equipment Division, has spotted the gap in the market: "The emphasis on robot utilization was up til now in automobile manufacture. The still relatively expensive robots with price-tags reading DM 100,000 to DM 250,000 for the basic device are used mainly in spot and seam welding and coating." A boom in assembly work is to start at last with the DM 60,000 swivel-arm robot.

The BMFT also recognized the possibilities of less expensive devices for assembly automation and granted within the framework of the production key point "Industrial Robots and Handling Systems: (DM 4.5 million) with DM 600,000 alone for the "development of a swivel-arm robot for assembly". The results of the promotion period from 1 October 82 to 30 June 1984 could be viewed on October 3 in Stuttgart-Feuerbach.

9243
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FACTORY AUTOMATION

CHINA WANTS TO BUY SWEDISH ROBOTS

Stockholm NY TEKNIK in Swedish 15 Nov 84 p 3

[Article by Goran Lundstrom]

[Text] China wants to purchase industrial robots and robot expertise in the West for $25 million.

As a part of this transaction, four Chinese experts recently concluded a week-long tour of Sweden. They visited researchers, robot manufactureres, and robot users.

The Chinese government has allocated the sum of $25 million to give China a genuine lift in the field of robotics during the next 3 years. Much of this money will be used to purchase expertise.

Handful Of Robots

At present, there are only a handful of robots imported from Japan operating in China. But 400 researchers are already active in this area and robot technology is taught at many of the country's technical universities. Chinese participation in international conferences on robotics is increasing dramatically each year.

The delegation, which was hosted by IVA (Royal Academy of Engineering Sciences), visited Saab-Scania, Asea, the Institute for Engineering Research, the Stockholm Institute of Technology, Atlas-Copco, and the Linkoping Institute of Technology, is one of several groups that are studying the situation in four countries: Japan, the United States, France, and Sweden.

The primary goal of the trip was not to purchase robots and systems, but to take home to China knowledge of robots and their applications.

Prominent researchers in the four countries may now expect invitations for month-long speaking tours in China. The Chinese are anxious to begin robot production. They would prefer to go directly to hydraulic and electrically driven robots with microcomputer controls and skip the intermediate stage of simple pneumatic robots.

At the top of the Chinese wish list are robots to be used for painting and robots for arc welding. Only then will they be interested in the simpler material-handling robots that we were developing in Sweden during the sixties.

The purpose of investing in automation for painting and welding is to eliminate the most unhealthy jobs and to improve quality.

9336
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FACTORY AUTOMATION

MBB AUTOMATES AIRCRAFT PRODUCTION IN MANY FRG FACILITIES

Munich FLUGREVUE in German Dec 84 pp 66-70

[Article by Hellmut Penner: "Fast, Economical and Precise: Automated Aircraft Construction in Germany"]

> [Excerpts] German wages and social security entitlements are the highest in the world. This seems to be in contradiction to remaining competitive in airplane construction, but production costs can still be lowered thanks to automation.

Japanese car manufacturers learned a few years ago what it was to be scared. They abruptly switched over from their manual production with high wages to automation. Prices dropped, quality leaped up, and nobody had to worry about sales. - A syndrome for the German car manufacturers in Wolfsburg, Ruesselsheim, Ingolstadt and Munich. Even complex welding- and assembly operations were handled by small robots.

The strictly programmed machines did not forget one screw and not one welding point. They worked with greater precision than a mechanic, who perhaps had not gotten enough sleep. And they did not need breaks for smoking, vacations or pensions. Their hourly wages are given with costs of less than ten marks.

Job Killers ? - far from it. By a very recent American study, automation even provides more new workplaces than had originally been assumed.

Completely new branches of the industry are created here. There are computer giants behind the manufacturers of the complicated robots.

Germany has learned from this. The German car makers have become more modernized in the meantime than the Japanese. The next step to automation was purposely started in a branch in which there are no high piece numbers. In airplane construction. The MBB company is a perfect example for this because, while the rest of the world was still manufacturing by the old methods, the German aviation and space travel corporation has quietly moved into the new age.

The first step towards automation was taken for the Tornado manufacture in Donauwoerth, but here everything is pretty much under lock and key for security reasons.

On the contrary, the northern dependents of the company were far more accessible. Production in the five plants Hamburg, Bremen, Varel, Einswarden and Stade is primarily geared to civil aviation. The products: Components for Airbuses A300, A310 and A320.

MBB is the German partner in Airbus Industrie.

The example of participation in the Airbus also illustrates that an airplane plant with utilization flexibility is much in demand.

After an order boom, the company management in Toulouse felt forced to reduce production rates strongly over the last two years. Before the PAN AM order for 91 airplanes, a further reduction in the production rate from the present three engines per month was to take place. Now, production management can maintain the rhythm and possibly again go up.

Investments have already paid off for MBB, and they have remained competitive through these automation measures.

The part price for individually manufactured structural components is lower than any individual part made manually. However, amortization of the facilities has not been completed as yet.

On the other hand, as partner in one or several large-scale airplane programs, the corporation is capable over the long run to manufacture with precision and - first of all - at a good price. At the start of the large-scale restructuring measures which are not yet completed to the last detail, MBB was faced with coordinating the widely scattered plants on the Elbe and the Weser. The key to automatic production lies in the CAD/CAM (Computer Aided Design/Computer Aided Manufacturing).

It is in the production sector, strictly speaking, that the degree of automation makes itself felt the most because of the low manpower component. In the Bremen MBB plant for sheet metal working, transfer carts run automatically over subterranean control systems to carry the sheet metal units for the NC machines which may weigh up to a ton.

Sheets are not cut or punched here by hand, they are optimally milled out by a sheet packet block. Optimization, naturally, also proceeded by the computer. The individual parts are given position numbers and are brought via a special conveyor system to the rubber press which operates at a pressure of 260 MN. Production pallets with about 15 parts can here be subjected to the difficult production process every one-and-one-half minutes. The press handles sheet thicknesses from 0.5 to 5 mm. The finishing touches on these sheet parts are in part still geared to manual work. MBB calls this production process CIAM (Computerized Integrated and Automated Manufacturing). CIAM reduces costs by 62 percent.

NC-controlled milling machines do not know breaks

The Varel plant has concentrated on machining. The NC-controlled machines run here practically without ever stopping. Complex riveting structures lend themselves better to manufacture of milled parts which are milled from the whole. The waste is directly taken to the aluminum smelting plant with alloy indication in recycling.

The Einsvarden plant manufactures fuselage shells. Automated riveting techniques and bonding techniques have made their entrance here. However, the proportion of manpower is higher because of the difficult work steps than in the other two plants. This applies also to the Stade plant which solely manufactures plastics components. However, the degree of automation could here be increased in partial sectors through improved technologies. The Hamburg plant in Finkenwerder at last makes final assembly of the fuselage shells into complete fuselage construction groups. Transition to other structures is possible at any time. As a company spokesman states, "if we have to supply other customers tomorrow, we are ready. Our automated production is so flexible that it can adjust to market requirements at any time. The mode of construction plays here a secondary role. And it is especially the high flexibility which protects us against our competitors."

Photo captions:
P. 66. Riveting robots work on fuselage segments which used to take weeks with a dozen workmen. Wing installation still requires manual labor.

P. 70. Multispindle milling machines permit simultaneous manufacture of identical parts (see top). The future lies in plastics, where tape-placing machines can adapt to complex shapes. Spherical shapes, on the other hand, still require manual work. The rubber press replaces an army of workers. Their chasing hammers made an infernal noise. This facility (below) is quieter than a domestic vacuum cleaner.

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FACTORY AUTOMATION

BRIEFS

ASEA-JAPAN ROBOTICS COOPERATION--ASEA and the Japanese tool and robot company Nitto Seiko have signed a cooperative agreement. ASEA Robotics will become the international distributor for Nitto Seiko's assembly robots and will acquire the exclusive right to market them in Europe. The robots covered in the agreement were developed by the Japanese company according to ASEA's specifications. They are designed for simpler assembly tasks but can also be used in larger systems together with an advanced ASEA assembly robot. [Text] [Stockholm DAGENS NYHETER in Swedish 23 Feb 85 p 10] 9992

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SCIENTIFIC AND INDUSTRIAL POLICY

EUROPEAN LEADERS DISCUSS HIGH TECH AS KEY TO ECONOMIC RECOVERY

Duesseldorf VDI NACHRICHTEN in German 23 Nov 84 p 29

[Text] Europe's economic and technological integration is still in its infancy. It is, however, an indispensible condition of economic recovery and new growth in all European countries. On invitation of the Economic and Social Committee of the European Community, almost 300 politicians, economists and scientists discussed problems of scientific and technological cooperation in Europe on 6-7 November 1984 under the title "Europe and the New Technologies." The focus was on large-scale manufacturing, information technology and biotechnology.

To be sure, there is a great deal of talk about Europe whenever things are going especially badly for real cooperation among the European nations; it may well seem valid, based on superficial examination, but it hardly does justice to the real problems. If the speeches of many European elected officials and representatives of the European Community are similar in their key statements, it is less indicative of their lack of imagination than of the fact that solving problems on the supranational--European--level is a time-consuming process.

National rivalries, different areas of interest of individual nationalistic groups and the variety of individual national laws and ordinances make a policy of "a thousand small steps" necessary.

Thus, in his introductory address, Etienne Davignon, vice president of the EEC commission, did not shy away from enumerating in particular the problems which stand in the way of European integration: isolation of national markets, contradictory ordinances and technical standards, hetrogeneous financial and business systems. The result: Europe is not managing to establish itself as an equal economic and industrial power--especially in the area of new technologies--with the economic superpowers, the United States and Japan. Thus the loss of millions of jobs becomes inevitable. Because of "technological nationalism" of European countries, European nations have been able to capture only 40 percent of the European market in the area of new technologies and just 10 percent of the world market.

Even Social Integration Is Still Lacking

Therefore Davignon called for the complete opening of national markets to European partners, the alignment of financial systems in order to consolidate a European service system and facilitate provision of venture capital and, finally, as one of the most significant factors, the standardization of technical specifications. Davignon considered the Esprit Program, which began in 1983 and in which over 10,000 European researchers will take part during the next 5 years, a successful first step.

Davignon's priorities were expressly supported by following speakers. Rolf Rodenstock, president of the Federal Association of German Industry, also added that in the past 10 years the EEC was the only one of the three great economic regions--Europe, the United States, Japan--which lost jobs. In contrast, in the United States from 1970 to 1983, the number of persons employed rose by about 21 million and in Japan by over 4 million since 1974. He stressed that the EEC with its 300 million consumers has a purchasing power greatly superior to that of the United States which, for reasons of economic survival, cannot be abandoned. According to Rodenstock, the state certainly should not replace the individual initiative of the entrepreneur.

George Debrunne, chairman of the European Federation of Labor Unions, went considerably farther into the social problems of European integration when he stressed that a common market also requires a common way of thinking, that alignment of social norms must accompany alignment of technical standards. He left no room for doubt that--in spite of the fear that the new technologies could develop into job killers--European labor unions stand with firm conviction behind the introduction of these technologies. In this connection, it was interesting that Debrunne definitely brought into consideration the possibility of European protective tariffs for a limited time to help build up new industries.

The status actually given European research and technology policy until now in the European budget was demonstrated with depressing clarity by Roberto Colombo, chairman of the Committee for European Scientific and Technological Development: The European Community spends more than 26 times as much for its joint agricultural policy than for research, technology and energy combined! Even to an impartial observer, it must be obvious that this is a persistent detriment to European integration.

From the meetings of the three working committees (1. New Technologies in Conventional Large-Scale Manufacturing, 2. New Information Technologies, 3. Biotechnology) the real problems of the new technologies for Europe became quite clear. The 5 million jobs lost in the last 10 years in the processing industries cast a real shadow over the discussion. It was therefore stressed that the new technologies can only be implemented on a broad basis with harmonious cooperation of employers and employees.

However, it has also become clear that it is in the interest of the labor unions not to be in too big a hurry to expose the traditional industries--especially the auto industry--to the chilling wind of competition from countries with cheap labor. Protective tariffs for traditional branches of large-scale manufacturing and growth tariffs for new high tech industries seem to be singled out as measures worthy of discussion in the circles of the European union leadership--in spite of all attempts to reduce international protectionism. The following figures demonstrate that, on the other hand, the potential for industrial rationalization has by no means been exhausted in the countries of the European Community: only 17 percent of all industrial robots are in the EEC, over 25 percent in the United States and over 55 percent in Japan.

For the information technology area, uniform European standards were recommended as a first step towards an international media cooperative; for biotechnology the necessity for a focused ethical vigilance was brought to the fore.

In fact, the danger was emphasized for information technology that there could be considerable duplication of effort on the national level which could become an obstacle to any compatibility of national systems. For the long term, a European telecommunications pool could offer a solution here. For now, however, these are just dreams for the future.

A Market Explosion is Foreseeable

The problems in biotechnology are different. According to a frequently quoted study, the market for biotechnological products will grow a thousand-fold in the next 10 years. An investment policy which is not coordinated on the European level would surely lead to considerable financial burdens which would stretch national budgets to their very limits.

In the area of basic research, parallel work on the same questions in several European countries could further delay catching up with the United States in biotechnological research. In the United States alone there are already 220 research companies in the biotechnology field which are endowed with considerable share capital: some are even listed on the stock market.

All conference participants agreed that there was no way to avoid implementation of new technologies on a broad basis. The prerequisites for such an implementation as well as for its acceptance by the people must therefore be established; thus, adaptation of education and training to the demands of the new technologies was given highest priority. Preparation will however also be necessary on the social level; the employee will need to become accustomed to the new work conditions, shorter work hours and, when necessary, even to greater mobility. All members of society have a challenging role to play in this.

A certain alignment will be necessary even in the economic and social infrastructures of the neighboring countries in Europe, perhaps merely a continuation of an already existing trend. Countries with high gross domestic products and predominantly high tech or at least technologically progressive industrial production in the north and predominantly agrarian economic systems functioning with antiquated technologies in the south. The imminent entry of Portugal and Spain into the EEC in 1986 focuses this trend.

There is, however, no alternative to European integration. Overcoming the technological lead of the United States and Japan will require efforts which no European country can manage alone and markets which are larger than mere national ones.

But in many cases the courage to take serious steps is lacking, and frequently the conviction that nothing can take the place of the European alternative is also lacking.

Therefore, Etienne Davignon came out especially against a lack of interest in European development, against a European pessimism the extent of which is becoming increasingly clear to him: "We successfully met the challenges of the first and second industrial revolutions; Europe has the potential to fashion itself a position of leadership in the third industrial revolution also."

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SCIENTIFIC AND INDUSTRIAL POLICY

RESEARCH PROJECTS, EUROPEAN TECHNOLOGICAL DEVELOPMENT CITED

Netherlands Tightens Research Subsidy Rules

Rotterdam NRC HANDELSBLAD in Dutch 13 Feb 85 p 11

[Article by Editor Paul Friese: "More Money Is Needed for Research Subsidies"]

[Text] The Hague, 13 Feb -- Without additional allotment measures Economic Affairs will have no more money for subsidizing promising industrial research projects. Large industries are devouring so much money with their applications for subsidies that other sources within the budget will have to be tapped. Moreover, even the small industries now want to take advantage of this form of support.

The ministry had not envisaged this great interest for subsidies on the part of industry and now a way is being sought for tightening the conditions for obtaining these subsidies. Thoughts on this matter are also leaning toward a maximum amount per project, such as is also taking place with INSTIR. This is the Innovations Stimulation Arrangement (1.1 billion guilders over a period of 5 years) in which industries can obtain subsidies over their personnel expenses up to a maximum of 900,000 guilders for research projects entailing a maximum of 5 million guilders. This arrangement has been in existence since 1 October 1984.

At any rate, under this sort of subsidy arrangement, if an enterprise is now doing a great deal or little research, it will be paid out no more than a maximum of 900,000 guilders in subsidies. Therefore, small industries with low research expenses fare better with this arrangement than is the case with large industries. However, this is exactly the other way around when it comes to subsidizing the remaining research expenses. Due to the fact that in the existing arrangements no ceilings have been set in the stipulations for the subsidies the big industries are the ones that are profiting the most.

Thus last year Philips obtained 190 million for the 5 year project that this concern is carrying out with Siemens of West Germany, while Gist-Brocades is getting 100 million for a likewise 5 year research project (a part of which is a development credit). Moreover Economic Affairs is still in the process of discussing matters with industries such as Akzo-Pharma and Avebe as well as with many small enterprises.

The great interest displayed by industry for these forms of subsidy is not only forcing Economic Affairs to toughen the conditions for obtaining subsidies, but also to utilize other items found within the budget of this department. This is necessary not only for enabling it to honor new applications, mostly coming from small enterprises, but also to meet the commitments made previously with big industries.

A total of about 700 million is available from the Economic Affairs department budget for supporting promising industrial projects in the framework of the so-called areas of attention policy. Out of this amount a supporting payment must also be made to Hoogovens and over the years this will total 1.1 billion; however, on an annual basis the amount will otherwise be considerably lower. On an annual basis the Innovation Stimulation Arrangement subsidy of 220 million still falls within the range of the available 700 million.

Those existing budgetary items, which now will also be used in supporting promising industrial projects, are probably the development credit, the interest bridging arrangement for shipbuilding and the matching funds for the export industries. This is because it now appears that Economic Affairs has money left over from these items.

In the Permanent Chamber Commission for Economic Affairs the chamber members are still in consultation with Minister Van Aardenne of Economic Affairs as to whether they can obtain more confidential information with respect to government support to industries. The purpose of this is to make it possible for the Chamber to exercise better control over this support. Van Aardenne has promised a confidential memo on this subject to the Chamber Commission.

Lubbers Wants Technology Talks

Rotterdam NRC HANDELSBLAD in Dutch 13 Feb 85 p 11

[Text] Brussels, 12 Feb -- Premier Lubbers wants to have a talk with the European Commission in Brussels as soon as possible in order to discuss the matter of providing better chances for technological development in Europe. This was announced yesterday by State Secretary for European Affairs Van Eekelen.

The premier wants to hold these talks at the end of February or the beginning of March and will be taking along with him some of his ministers. Jacques Delors, the chairman of the European Community Commission, and some members of the commission have already been invited for these talks.

During the past European summit conference in Dublin Lubbers already advocated that the European Community must provide more opportunities in the technological development field. According to Van Eekelen the Dutch government is now determined to delve into this matter in three ways: The development of the technology itself, Improvements in the workings of the European internal market, and the "external aspect."

What is meant by the past point is that there must exist a possibility for modifying and possibly increasing customs duties on certain imported eminent technological components. Van Eekelen went on to say: "To be sure we are then going to be accused of protectionism, but this is a matter of whether or not we, in Europe, will want to have and maintain a 'spearhead industry.'"

According to the state secretary the plan is to have the talks between the Dutch ministers and the European Community Commission arrive at conclusions which could be incorporated into the preparations for the next European summit conference which is to be held in Brussels on 30 and 31 March.

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SCIENTIFIC AND INDUSTRIAL POLICY

SWISS EXECUTIVE ON EUROPE'S TECHNOLOGICAL STRENGTH, WEAKNESS

Zurich NEUE ZUERCHER ZEITUNG in German 27 Feb 85 p 30

[Article by Prof Dr A.P. Speiser, Head of Research at Brown Boveri*: "European Technology Between the Poles of America and the Far East"]

[Text] The position of European technology between the poles of America and the Far East is a theme of pressing relevance; everyone who is concerned with the technological future of our continent must deal with it and that means all of us for whom the fate of our national economy is a matter of concern.

The discussion of the "Technological Gap" in the sixties emerged chiefly from the impression of the strength of the United States in a limited number of clearly delineated areas: transistor technology, computers, nuclear energy, commercial aircraft, space technology and telecommunications. Thoughtful observers were already pointing out that these strengths contrasted with a group of areas which were characterized by a clear lag compared to Europe.

Two contradictions are especially obvious: the first results from the fact that technology is based on science and that the United States is indisputably by far the leading nation in pure science; since 1945 more than half the Nobel prizes for natural sciences have gone to the United States. And second, we must acknowledge that the American venture company tradition manifests a strength for which neither Western Europe nor the Far East can produce an equivalent. By that we mean the smoothly functioning interplay between investors and young, dynamic entrepreneurs who take on a few years of hard work. How could any other region of the world where the qualifications are seemingly much less favorable accomplish such a breakthrough?

No one will dispute the fact that the rise of Japanese technology surprised the West. In Japan, I visited research directors of large firms, university professors and government officials and asked each one of them: How did you do it? In response, the two factors of training of engineers and production engineering were consistently cited.

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*Research report presented to the Zurich National Economic Society on 20 February. Editorially abridged version.

Transistor technology, of purely American origin, was adopted very early as an area of national emphasis. The implications of this pivotal decision are immeasurable, for the transistor is by any standards one of the three or four most economically significant inventions of our century.

Computer technology rapidly developed as one of the applications of the transistor. However, in contrast to the West, because of the complexity of the language characters, the computer could not be used for office automation in Japan; the consequence was an early and determined transfer of emphasis to computer assisted factory automation. The national characteristics of technical talent, manual skill, strong quality consciousness and a marked tendency for team work allowed the Japanese to attain a leading position in large-scale manufacturing which they now enjoy. Two very distinct capabilities have developed from it: transistor technology and mass production.

It is indisputable that the beginnings of the rise of Japanese technology were based on sheer imitation of foreign concepts. This phase is largely past, but a watchful interest in Western developments has remained. Publications are meticulously followed, and whatever seems useful is appropriated. On the other hand, it cannot be claimed that the Americans are responding in kind. Their fixation on their own technical strengths has until recently led to ignorance of foreign developments, a stance which must be acknowledged as the cause for the loss of important jobs.

Outlook for Western Europe

How can we assess the future of European technology between the poles of the United States and Japan? The following distinctive strengths demonstrate the potentials for success of those two regions:

United States:

--Great entrepreneurial agility.
--Geographic mobility of management.
--Close linkage of science and technology; strong research management in large firms; venture company tradition, based on a well-orchestrated interplay between young entrepreneurs, universities and financial backers.
--Undisputed position of leadership in science, which rests on some two dozen elite universities.
--Strong influence of military and space-related national research programs on the civil sector: if President Reagan's "Star Wars" program is carried out, then significant new impulses in civil technology will result, especially in the high tech areas such as microelectronics, laser technology and information technology.
--Significant imigration of scientists and engineers.
--Liberal mind-set, aversion to the excessive taxation of the welfare state.

Japan:

--Good, qualitatively even education on all levels; twice as many engineers (in terms of percentage of a year's class) as in the West.

--Semiconductor (transistor) technology felt to be "national technology"; considerably higher share of this particular growth area in the gross domestic product than in the West.
--Position of leadership in mass production.
--Company loyalty, little job changing, diligent and conscientious work.
--Basic technical talent of the population, positive attitude of the general public toward technical innovation.
--Intact feeling of nationalism.

The two great giants, the United States and Japan, are facing each other today on the electronics front. Both have their important strengths. Silicon Valley is probably the most significant electronics concentration in the world; together with Stanford University, it represents a tremendous intellectual and entrepreneurial potential.

The reaction of Western European countries to the challenge of the West and the East is varied, and the opinions about what should be done are quite divergent. There has been no lack of attempts at improvement. The Esprit program is unquestionably a significant plan of this type. Esprit stands for European Strategic Program of Research in Information Technology. It consists of a merger of 12 original firms from EEC countries which are undertaking a carefully coordinated joint research program. The average investment for the next 5 years amounts to at least 2.7 billion Swiss francs--an ambitious goal, to be sure, and one which is a departure from anything done previously. It is cause for alarm that half of this gigantic sum is to be contributed from the treasury of the EEC, raised by taxpayers in other words--a welcome gift for the companies involved, but a less pleasant occurence for those left standing at the door, since they are located outside of EEC territory. From the descriptions of the plan, it is clear that it includes all those themes of information technology which are currently highly topical and which Swiss businesses must also deal with if they are to be involved in new technologies. But they must pay for their own research while their competitors receive a 50 percent subsidy and thus guarantee themselves a considerable cost advantage. And they will be denied access to the pool of information through which the Esprit partners will exchange their knowledge and experiences.

Research and Development in Switzerland

This year in Switzerland about 5 billion Swiss francs are being spent for research and development. That is 2.3 percent of the gross domestic product. This puts us in the category of the eight most researth-oriented countries. The state provides 25 percent of this amount, business 75 percent; in other countries, the distribution runs about 50 : 50, with the exception of Japan, where the ratio is the same as ours. Ninety-five percent of private economic research and development is allotted to two groups--the chemical industry and VSM [Swiss machine industry] companies, and only 5 percent to clocks, textiles and all others.

Although Switzerland is one of the three smallest countries in Europe, we have a considerable palette of scientifically and technically significant areas

where our industry is capable of worldwide competition. If one considers our industry exclusive of the chemical industry, then it is no doubt the areas related to electronics where strong growth impulses will be felt now and in the foreseeable future.

Switzerland is not on the front in this effort. Of course there are some industrialists who had the vision to recognize the signs of the times and who established the necessary electronics capabilities at the right time; but their share of the total is too small for our national economy to have been stimulated like that of Japan.

Every attempt to compare Switzerland with Japan leads sooner or later to the central theme of the training of engineers. Switzerland has too few engineers. Our 2 technical universities grant some 1,100 diplomas per year; our high technology professional schools and technical night schools grant 1,900, for a total of 3,000. That represents 3 percent of each individual year's graduates. In Japan it is 6 percent. Here we are faced with so great a difference that it simply cannot be ignored.

In Switzerland we have an acute shortage of engineers which is concentrated in the two professions of electronical engineers and information technology engineers. The labor market has dried up, with the inevitable effects on salary structures and job changes. The fact that an increase in the number of engineers is in pressing national interest alone will not produce enough. Furthermore, the shortage of computer scientists is such that undertaking really large software projects is a practical impossibility in Switzerland; the failure of the integrated telecommunications system of the PTT[Post, Telegraph, Telephone] is also directly related to this.

Postulates

I offer the following few proposals which I will summarize in five postulates.

More Professors and Assistants

1. The first postulate is tied to the pressing need for an increase in the number of engineers. Fortunately, admissions to the ETH [Confederated Technical University of Zurich] are increasing sharply. But the 10-year-old personnel freeze with no exceptions concurrent with a one-third increase in student population is leading to a decline in the quality of instruction. Although the possibilities of transferring personnel from other areas have been exhausted, the number of professors and assistants in electronics and information engineering is still absolutely inadequate--the situation borders on a cirsis. An additional contingent of professors and assistants in these two areas with definite time limits (that is, until student population stabilizes) is absolutely necessary.

More Work Permits for Foreigners

2. The second complex of issues concerns work permits for foreigners. The shortage of engineers could be alleviated by foreign engineers, but our laws

prevent that. Of course we cannot blame our officials for a lack of understanding since they are bound by regulations. In most cases approval is forthcoming for especially well-qualified researchers. But as a rule such variances are not made for recent engineering graduates. It is especially shocking that a foreigner who has studied at the ETH can only rarely count on a job. In other words, he must leave the country upon graduation, after the taxpayers have spent a good 150,000 Swiss francs for his education and even though he is urgently needed here in this country.--How many permits would be needed? As an example, let's say that each year about 300 electronics engineers and information technology engineers are educated by our universities. An additional foreign contingent of half this number, or 150 per year for a few years, would be a great help. The confederation and the cantons presently have at their disposal a yearly contingent of 8,200; within this, these 150, earmarked for these two professions, ought to be justified.

3. The third concern deals with the Swiss National Fund, which disburses 165 million Swiss francs annually for the support of research and has therefore become the most significant factor in Swiss science. It is faced with a growing scarcity of funds. But good research is also an aspect of the education of engineers. Doctoral candidates are researchers who simultaneously play an important role in education. An increase in funds for the National Fund dedicated to research in the engineering sciences would respond to a national need.

The State and Venture Capital

4. My fourth postulate concerns venture capital. It is indisputable that in Switzerland the venture company phenomenon is nowhere near so vigorous and successful as in the United States. Why is that? The cause is not to be found in a single source; there are several factors working together. There is much debate as to whether there actually is a shortage of venture capital. Such a shortage cannot be denied out of hand. But everything points to the fact that the investor is not so wary of the risk of loss as of the national treasury. The assortment of regulations according to which the public hand takes its share of proceeds from venture capital suppliers is well known; I will limit myself to key words: taxation of proceeds from investments, while, in contrast, in other countries investments are favorably treated in taxation; progressive profits tax on corporations according to the size of the profits; inclusion of corporations in the church tax; especially unfavorable for stockholders are the double taxation of profits and dividends and the regulations for the valuation of unquoted shares as well as the double taxation of shareholders in succession.

University and Industry Linkage

5. My last concern deals with the linkage of the spheres of interest of our universities and our industry. All too often it occurs that a researcher from one of our universities finds no one interested in a good and valuable idea in Switzerland, but must go abroad; on the other hand, our industrial researchers must travel to foreign universities for essential scientific support. The

capability profiles of our universities and our industry are too divergent. The chemical industry has less reason for dissatisfaction; the electrical industry however has more. Its foreign competitors have better support from their universities. An improvement would be desirable in Switzerland. But a shift of research emphases in the universities is a time-consuming process, and, in contrast to other countries, we do not have a minister of technology to mandate and implement such a process.

Attitude Toward Technology

What would seem to be the outlook for the fulfillment of these postulates? The answer is: varied. We should work purposefully for their realization; the demands are not excessive, and do not go beyond reality; their fulfillment would effect a considerable improvement in the marginal conditions for technical innovation in our country.

There is one more marginal condition which is actually as important as all the aforementioned items together: public opinion, the value the general public places on technology. In Western Europe we find a widespread dualistic attitude toward economic growth and technical progress. On the side of material wishes, a desire for growth comes unequivocally to the fore; but the technical and structural innovations which would be necessary to acquire additional funds are met with much skepticism; and the legislatures which mirror public opinion translate these views into political action. While the United States and Japan are engaged in competition for mastery of new technologies, we are indulging in sociological studies about whether microelectronics might not eliminate more jobs than it creates.

Industrialists

The prime movers in technical innovation are neither the state nor the public, but rather the industrialists; and the question is justified whether industrialists have always acted in the best possible way and whether it is always the fault of others that our industry has lost ground in many modern fields. To answer this question with an unqualified "yes" would be to close our eyes to reality.

An old proverb among engineers states that it is easier to make research products from gold than to make gold from research products. There are some industrialists who have successfully mastered both tasks and have assured themselves a share of the market in modern fields. Others have renounced research and thereby reduced costs but lost markets. And it will remain so in the future. Technical innovation for its own sake is certainly no guarantee of entrepreneurial success, but without it there is no alternative for any industry based in Switzerland. However, technical innovation is no easy task. The industrialist who does not grant his researchers the freedom which is essential to the success of truly innovative ideas, who therefore gives his researchers only short term assignmmets with sure goals and who carefully attempts to prevent their making any mistakes, the industrialist who does not consider the assurance of lasting, positive contacts with universities as

important business tasks but rather as administrative sidelines which can be delegated to lower level employees and do not need to be overseen will be forced into product areas where surpluses and price reductions are the rule, and he will continually find himself in markets where risks are great and profits are small.

The Future

How then can we assess the future of European technology, especially Swiss technology? There is, to be sure, no call for excessive optimism; the great potentials for success that the United States and the East have are too substantial for that. Yet pessimism is also out of place; pessimism begets resignation, an extremely unfavorable foundation for business directed toward the future. Western Europe has clear strengths upon which it needs to build. Compared to America our educational system is superior at many levels. Compared to Japan, our scientific backing of technology and the flow of knowledge from universities to industry are better, and also the quality of general industrial leadership and research control are higher; furthermore, most European countries are more successful than Japan in attracting highly qualified immigrants. In contrast to both regions, Western Europe has the advantage that both management and labor are more cosmopolitan and more linguistically knowledgeable. I am confident that we will succeed in building on our strengths and in reestablishing the balance among the three regions.

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SCIENTIFIC AND INDUSTRIAL POLICY

STUDY OF INDIVIDUAL FRG FIRMS REVEALS STAGNANT R&D INVESTMENT

Munich INDUSTRIMAGAZINE in German 15 Nov 84 pp 154-155

[Excerpts] In 1983, U.S. firms once again did more for the future. It was a totally different story for German firms.

"In 1983 the firms we studied give the impression that the doldrums have struck again," regretfully reports business management professor Klaus Brockhoff from Kiel, who has been analyzing German business preparations for the future since 1964. For, according to the report of wage increases: research and development expenditures remain stagnant at last year's level (see table).

Individual reports from German firms also fluctuate widely around the modest average. Unilever and Esso have discontinued their German research activities and transferred them abroad. In several firms expenditures have decreased--again at AEG and Ruhrkohle--or stayed roughly at last year's level, at BASF and SEL for example.

Front runners in expansion of research activities are Nixdorf, Schering and Wacker Chemical.

As always, the R&D data from German firms are only partially comparable, since they are not uniformly defined in company reports. Brockhoff wonders, "How will this be handled in the future when it is necessary to report on R&D in conformity with EEC regulations?"

EXPANSION SLOWED AGAIN

What German Firms Spend for Research and Development

Firm	Division	R&D Expense In Millions Of DM		Research Rate* In Percent		1983 Research Emphases
		1982	1983	1982	1983	
AEG (Concern)	Electronics	843	741	6.36	6.43	°Automation °Prototype creation °Optical communication technology °Microwave technology °Solar technology °Microminiature electronics, microminiature components °Modern drive systems
Aesculap	Medical Technology	-	8	-	4.60	°Knee and tumor endoprostheses °Dental instruments
BASF (Group)	Chemical	1335	1316	4.11	4.31	°Technical specialized chemicals °Pharmaceutics (heart-circulation, central nervous system, stomach-intestinal diseases) °Fertilizers to supply plants with trace elements

*R&D expenditure as percentage of business turnover

Firm	Division	R&D Expense		Research Rate		1983 Research
Bayer (International)	Chemical	1550	1694	4.45	4.45	°Nutrition °Health
Bayer AG		864	918	6.50	6.27	°Computer technology (Agfa-Gevaert) °Plant protection °Pharmaceutics
BBC [Brown Boveri]	Electronics	500	540	10.00	10.91	°Diffusion bonding processes °Electronic sub-assemblies and production technologies °LSI [Large-scale integration] °Drive trains for electric vehicles °Computerized design and planning systems for power plants
Boehringer Ingelheim (Group)	Pharmaceutics	368	400	15.81	15.14	°Heart-circulation °Central nervous system °Respiratory tracts °Stomach-intestine °Immunology/Allergy °Metabolism
Boehringer Mannheim	Pharmaceutics	144	174	14.00	15.00	°Heart-circulation °Metabolic diseases °Immunological and Test strip systems
Robert Bosch (International)	Electronics	703	729	5.08	5.08	°Microelectronics °Communication technology °Sensors (miniature) °Radionuclide measuring techniques °Digital simulation °Construction materials °Finishing techniques °Computer assisted design °Energy and environment

Firm	Division	R&D Expense		Research Rate		1983 Research
Chemische Werke Huels	Chemical	160	160	3.18	3.10*	°Biotechnology °Process chemicals °Refined chemicals °Technical design materials
Daimler-Benz (Concern)	Automotive	1400	1500	3.60	3.75	°Reduction of fuel consumption °Reduction of emissions °Noise reduction
German Shell	Petroleum	58	38	0.26	0.20	°Motor and machine oils °Unleaded fuel °Ash emission in heavy heating oil combustion °Lowering pollution in lubricant manu-facture °More efficient use of crude oil
Draegerwerk	Medical Technology	35	35	7.45	6.70	°Medical technology (increased use of microelectronics) °More reliable mat-erials °Electronic gas measuring technologies °Monitor measuring technologies °Air and space travel
Dynamit Nobel (Group)	Chemical	75	80	2.67	2.79	°Specialized explo-sives and detonation devices °Chemical synthesis with special safety requirements °Intermediate organic products °Lubricants °Fully organic molding materials
Enka (Group)	Chemical	117	120	2.93	3.03	°Asbestos Substitute (Aramid) °Medical membranes °Industrial synthesis °Synthetic fibers

*Estimated

Firm	Division	R&D Expense		Research Rate		1983 Research
GHH (Group) Gutehoffnungshuette	Machinery	613	549	3.28	3.50	°Energy and nuclear technology °Space flight and communications °Study of materials °Control technology °Lightweight construction
R. Hell	Electronics	47	49	10.59	10.90	°Newspaper page transcription system °Copy technology
Henkel (Concern)	Chemical	204	207	4.92	4.65	°Sulfonation of lubricants (new production processes) °Optimal utilization of raw materials and energy
W.C. Heraeus (Concern)	Metals, Medical Technology	32	34	1.06	1.26	°Lasers in medicine and surgery °Biocompatible implant components °Special ceramics °Contact alloys °Preparation for assembly of hybrid switching networks on steel substrata
Hoechst (International)	Chemical	1561	1617	4.46	4.35	°Biotechnology °Health
Hoechst AG		742	726	6.01	5.58	°Nutrition °Communications °Energy and raw materials °Environmental protection
E. Merck(Group)	Pharmaceutics	143	160	5.74	5.99	° Heart-circulation °Central nervous system
E. Merck(Concern)		113	128	9.33	9.93	°Biomaterials
Messer Griesheim	Chemical	51	51	3.18	4.60	°Gas handling and special gas mixtures °Low temperature manufacturing processes °Biotechnology and medicine °Gases and low temperatures in food processing

Firm	Division	R&D Expense		Research Rate		1983 Research
Messer Griesheim (Continued)						°Electron beam and CO_2 laser technology °Sensor technology
Messerschmidt-Boelkow-Blohm	Aircraft	200	215	3.52	3.66	°Heavy-duty fiber lamination materials °Microelectronics °Cybernetics °CAD/CAM production control
Nixdorf (Concern)	Electronics	197	254	8.61	9.40	°More error-tolerant general purpose computer °Communications technology °Artificial intelligence
Ruhrkohle (Concern)	Mining	279	268	1.59	1.46	°Improvement of cost-effectiveness of mining and subsequent processing °Coal refinement °Environmental protection
Saarbergwerke AG	Mining	220	108	3.57	2.00	°Coal mining °Coke technology °Power plant technology °Liquifying coal °Waste heat and solid waste reclamation °Uranium ore mining
Schering(Group)	Pharmaceutics	349	433	9.95	10.10	°Heart-circulation °Central nervous system
Schering AG		269	302	14.85	15.20	°Plant protection °Genetic engineering °Printed circuitry °Epoxy resin systems °Flotation agents for coal extraction
SEL (Group)	Electronics	429	425	11.77	11.66	°Digital switching technology (System 12) °Transmission by copper and glass
Siemens AG	Electronics	3400	3500	8.48	8.86	°Software °Microelectronics °Production automation °Medical technology

Firm	Division	R&D Expense		Research Rate		1983 Research
Telefonbau + Normalzeit	Electronics	-	100	-	6.07	°Digital telecommunications systems °Bigfon °Data transmission
Volkswagenwerk AG (Concern)	Automotive	1348	1443	3.60	3.60	°Emissions research °Subcompact development possibilities
Wacker Chemie	Chemical	70	85.6	4.50	5.01	°Biotechnology °Odoriferous materials °Information technology °Innovative materials from slag °Plant protection
Carl-Zeiss	Precision Mechanics, Optics	80.4	89.2	9.60	9.30	°Optical medical instruments °Infrared technologies °Special vision aids

Source: Calculations by Prof Dr Klaus Brockhoff, Institute for Management Studies, Kiel University

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SCIENTIFIC AND INDUSTRIAL POLICY

40 MILLION DOLLARS FOR LASER RESEARCH

Rome IL TEMPO in Italian 22 Jan 85 p 17

[Article by Giuseppe D'Avanzo: "High Priority for Continued Study of Numerous Laser Uses"; announced in Milan by minister of scientific research, Senator Granelli]

[Excerpt] The Minister of Research has assigned "high priority" to the CNR's continued study and experiments in the uses of the laser carried out under the new "Electronic Technologies" project (80 billion lire over 5 years, in 1985 lire) after having verified the results obtained in the previous project "Power Lasers," carried out between 1979 and 1983 at the cost of 23.8 billion lire. Among other things, the "Power Lasers" project allowed one of the eighty organizations involved, the Italian Center for Study and Experiments (CISE) in Milan (a research group which is 98 percent financed by ENEL), to work with Alfa Romeo to develop the first Italian power laser for industrial use. That laser (in use at the Portello factory) will be demonstrated tomorrow.

Before Minister Granelli's announcement, a number of speakers pointed out the results of the "Power Laser" project as they appear in the practical stage in the Portello factory system.

The focus of the new project will be centered on laser technology, as classified in the following four sub-projects: (1) systems for manufacturing and industrial diagnostics (leading to, among other things, the automated factory); (2) active and passive electro-optical components; (3) systems for computers, the environment, and defense (we are getting closer to a working digital computer using optic signals); (4) systems for biomedical uses.

The biomedical uses being considered are microsurgery for the eye, the nervous system and for gynecology, as well as photochemotherapy for tumors. The latter will be developed in conjunction with the Institute for the Cure of Tumors in Milan. It involves the injection of a dye into the blood, and the illumination of the dye by the tumor cells. When the dye separates the tumor cells, it should cause the destruction of those same cells.

After his mild criticisms, Granelli commented on the decline in usefulness of the results of the previous project, while indicating the mobilization that these initiatives had caused in Italian technological circles. He also pointed

out the practical potential of the new project, and the fact that the new program is innovative, not simply a repetition of its predecessor. Finally, Granelli alluded to the fierce international competition in laser research. Because of all of these factors, and given, of course, the previous favorable opinion of the CIPE, high priority has been assigned to continued laser research. One assumes that "priority" means with respect to the other fourteen new projects that the CNR is due to initiate. These projects will be funded through the resources that spring from the rationalization of the CNR being undertaken by its new president Rossi Bernardi.

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SCIENTIFIC AND INDUSTRIAL POLICY

FRG GOVERNMENT, SIEMENS BUILD HIGH-TECH FACILITIES IN MUNICH

New Siemens Factories for 'Megaproject'

Munich MUENCHNER STADTANZEIGER in German 8 Feb 85 p 3

[Article by Karl Stankiewitz: "Munich, Microchip Mecca. New Research in Electronics in Neuperlach"]

[Excerpts] "By the end of 1986 at the latest we will be the first in Europe to catch up to the Japanese and Americans," says project head Hans Friedrich. About 7000 of the 41,900 engineers and other workers employed by Siemens in Munich alone are working at high speed on a silicon component no larger than a fingernail which is said to be the basis for the next, the third generation of microelectronic components.

These for the most part younger people have been concentrated--not solely for this task--in the new "think tank" of Germany's largest privately owned employer: at a complex of 22 interconnected buildings, each named after a different variety of tree, covering a total area of 350,000 square meters. The complex also has a direct subway connection, underground connections between buildings, laboratories which are germ-free and vibration proof, the largest computer center in Europe, its own school for data processing, three "logical" color-coded areas and an alert plant security force which is everywhere, even patrolling on bicycles.

Right next door to Munich on the outskirts of Neuperlach where over 100,000 people already live and work, the future of the "electronic society" has already begun. In the 1990's the computer with the Munich microchip will be four times more powerful, but also four times cheaper, smaller and faster than what is available now. All this is expected of the megabit memory developed at the Siemens think tank and set to go into mass production at the new Regensburg plant as of 1987.

Additional Plant Locations

The "Techno Center Muenchen" is going up directly across from the new research center, which employees this past cold winter called "Data-Siberia". In its eight buildings with 30,000 square meters of space for rent, manufacturers, distributors and users in the "high technology target group" will be able to

begin competing with the famous centers in Japan and the U.S. A hotel for visitors from all over the world will also be included. Borrowing from California's "Silicon Valley," the site of flourishing electronics companies, George Ophof of Holland on a visit to the not yet completed structure spoke of a "Municon Valley"; his company, the largest private retirement fund company in the Netherlands, is investing DM 107 million in this new research project in Neuperlach.

The Bavarian capital, together with a large area around it, has indeed very quietly, as this complicated world dictates, become a "microchip Mecca." It is drawing more and more technical specialists and management people--and probably also a number of technology freaks, utopians and speculators. "The most progressive areas of the German economy are migrating more and more rapidly to the south," was the conclusion of an industrial consulting firm in Frankfurt. There is already a lack of qualified specialists both at the advanced schools and in the job market, sighs Helmut Bettermann, head of personnel at the communications division of Siemens.

In Munich last year the company, in the central research and technology division alone, hired 320 qualified new employees (starting salary DM 3500/month). Another 2800 engineers are to be added in 1985. At the same time over DM four billion are to be spent for research and development alone during the next fiscal year. In many areas already "clearly at the forefront," is how Prof Karl Heinz Beckurts, head of research at Siemens, describes the current "anticipatory mood" which is also expressed in the approximately 400 developments underway.

Other large firms in the electrical engineering and electronics industry have also recently moved increasingly to Munich and Bavaria where one in four jobs in this branch of industry now already exists. International firms such as Hitachi, Digital, Sanyo, Murata, Texas Instruments and Fairchild have established branches between the Isar and Lech rivers. Computer giant Nixdorf will be added to the list this year.

Anton Jaumann, Bavaria's economics minister, is currently in the U.S. negotiating additional company sites with such companies as the market leader Wang and the telephone giant ATT, among others. "Whoever wants to keep step in the electronics field in Europe must have one foot in Bavaria," is the opinion of Jaumann's press spokesman Bernd Lenze.

The disadvantages of its remoteness and distance from a deep sea harbor have brought other benefits which are now beginning to come to fruition, is how the clever Jaumann describes the new role of this Land once dominated by agriculture and particularly of Munich which itself has already surpassed West Berlin and Hamburg as the FRG's largest industrial city (employing 170,000 people of which 50,000 are in the electronics industry). An additional 10,000 jobs were created in the past few years in Bavaria in the field of microelectronics alone (the electronics industry is already in first place with 230,000 employees, of which 110,000 are in the communications industry).

Catching Up With the U.S. and Japan

Within this decade another 20,000 jobs are expected to be added in these areas. Bavaria intends to make approximately DM 42 million available by 1988 for funding non-university, application-oriented research in the field of microelectronics. A "venture capital investment company" with DM 18 million in capital was recently founded by 10 Bavarian banks and 2 insurance companies. In order to guide and promote development, Jaumann has had a study done at a cost of DM 350,000. He only alludes to one of its initial results: A leading European electronics firm has decided to build a state-of-the-art production plant in Bavaria at a cost of billions and to "catch up" with the competition in Japan and the U.S. within this decade by taking the appropriate steps.

But it is not just the giants in the industry or their "brains" which draw people to the Bavarian capital. The city also offers these, for the most part thirtyish, "egg heads" the necessary leisure time activities, for example, as well as five international electronics trade fairs. In the final analysis, progress in the world of microchips, as the American "Silicon Valley" has shown, is not just something for small but venturesome hobbyists, inventors and entrepreneurs. Therefore, the city of Munich, together with the Chamber of Industry and Commerce and the Chamber of Handicrafts, has built a 3000 square meter "Technology Center" on an old commercial site where young companies, enticed by the low rent, service facilities, consultation and support, can busy themselves with "forward-looking technologies."

Technology Park in Westend

Munich SUEDDEUTSCHE ZEITUNG in German 23 Feb 85 p 17

[Article by Thomas Muenster: "Rosy Outlook for 'White Industry.' In Munich New Technologies Get Public, Private Funding. Chance for Creative New Generation"]

[Text] The "black" industries of the FRG with their smokestacks, slag heaps and production derricks are increasingly falling into economic distress. The "white" industries, on the other hand, clean, forward-looking, innovative, are clearly moving in the other direction. That the new branches of industry employing modern technology have become so very concentrated precisely in the "industrial city" of Munich may be coincidence or may be due to the particular appeal of this city. That they also stay in the city, that additional people are sought out, drawn in and given assistance, is of course a matter of active promotion. Three things which tend to "grab" newcomers, even though of no immediate benefit in dollars and cents, are offered by the city itself, a nonprofit organization and a private company.

To call Munich the "Silicon Valley" of the FRG, as seen repeatedly in advertising brochures and superficial articles recently, is as silly as it is misleading. This valley in the California desert has become famous as a highly specialized kind of microelectronics "monoculture"--making it therefore very sensitive to cyclical influences--and has become a catchword. In Munich on the other hand, the new technologies being cultivated are amazingly diverse.

Test Model on Commercial Site

Electronics and microelectronics are naturally included, but also laser technology, propulsion technology, biotechnology and genetic engineering and many other research-intensive areas are the "target groups" for which the Bavarian capital has reserved about 3000 square meters of space in the new Westend commercial site. The idea for creating a technology center was given concrete form in a decision passed by the city council just one year ago, in February 1984. The site first considered was one of the former IGA administrative buildings. When the necessary renovations were shown to be too time consuming, the city council decided on the commercial site where the "test model for new businesses in high technology" is set to begin. On November 22, 1984, the full city council approved the founding of the "Munich Technology Center Co." which was officially registered that same month.

Assistance in Bookkeeping and Tax Law

Rudolf Schwarz, head of the city's economics office, says that this company's objective is to give the courageous founders of new businesses "intensive assistance" in less well-known or entirely new areas of research and development. Assistance will be offered not least of all in the area of commercial subjects. According to Schwarz, while a skilled tradesman is taught the basics of bookkeeping and tax law during his vocational training, the young people in the advanced schools and universities are in this regard "not encumbered with such matters and are also not expected to waste their time on them."

Regarding the success of the test model, Schwarz is "optimistic." The close proximity of offices at the commercial site will itself promote "a substantial amount of technology transfer", as will the nearness of the numerous technical universities and university institutes. And facilities such as the Max-Planck-Institute and the Fraunhofer Society should also not be forgotten. There are already about 30 interested applicants.

Both Bavaria and Federal Government Pay

The city, which in addition to both chambers mentioned above is the leading partner in this enterprise, will not have to make large investments. The Land government of Bavaria, although itself not a partner, will carry half of the costs "up to a certain maximum figure." Funds will also come from the TOU program of the BMFT. TOU stands for "technology-oriented, newly founded companies"; the program distributes funds throughout the FRG and according to its guidelines does not really apply to Munich. However, the entire microelectronics field is considered an exception, as are communities which want to construct a "recognized technology center."

In four years the test model will be concluded, says Schwarz when asked about subsequent costs. After, at most, a three- or four-year "dry period" following the founding of such an unconventional enterprise, it would have to be apparent whether an idea or a development is a flop or whether it is ready to leave the "incubator" of the technology center.

"Inventors Central" Planned

Innovation--this is the common denominator of all of these types of facilities for promoting technology. The Deutsche Aktionsgemeinschaft Bildung Erfindung Innovation (DABEI) (German Corporation for Education, Invention, Innovation) was founded more than two years ago by the president of the FRG patent office, Erich Haeusser, and other leading members of the "innovation scene" of the FRG for the express purpose of "improving the 'climate of innovation' in our country through coordination and recommendations based on expertise." DABEI's regional group in Bavaria has as its goal to institute an "inventors central."

The city council indicated last year already its "basic agreement" that this inventors central move into the old Moll building at Westpark. The economics office is currently looking into the details. According to Siegfried Greif "various kinds of inventors workshops" are to be erected there. DABEI has three goals for this project: to advise inventors on an individual basis as well as in seminars and to encourage gifted young people. Greif, a member of the board of DABEI, is emminently competent to oversee this project which is supported by monetary and material donations from industry: His "special assignment" at the patent office is to develop a kind of "early warning system" and to view patent information as "indicators of research and development activities, of technological change and of international technical and economic relations." By supporting gifted young people, says Greif, DABEI in no way wants to preempt federal assistance to the gifted, but rather wants simply to "get a head start on seeking out and developing technical creativity."

Private Sector Was Quicker

Both the city's project and that of the non-profit organization are currently under development. The private sector, as always, is a little ahead. In November 1984 the outer structure of the "Techno Center Muenchen" was completed and will soon be ready for occupancy. This gigantic complex being built on Carl-Wery-Strasse is the first privately financed technology center in the FRG. The owners foresee small- and medium-sized companies in the growing microelectronics field as their future tenants. With this project private enterprise nicely rounds out the supportive efforts at the federal, municipal and non-profit organization levels. In such enterprises there is room for "venture capital financing" of tinkerers, inventors and researchers: The potential investors can write off any losses, while successes will bring profits which will make the risks worthwhile. "Someone has an idea and someone else has the money," is how Rudolf Schwarz describes the concept of such private technology centers. "If the two can be brought together, even in an unconventional way, there will naturally be more capital available than a municipality like Munich would ever be able to afford."

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TECHNOLOGY TRANSFER

BFIEFS

FINNISH CABLE-MACHINERY TO CHINA--Nokia will supply equipment worth 65 million markkas to a Chinese cable factory. The deal provides for production lines for power cable and telephone lines plus a roboticized control cable unit built entirely by Nokia. A spool-handling robot is part of the control cable unit. The machines represent a new technology for producing cable. More than two-thirds of the equipment are to be delivered this year. Part of the delivery, however--approximately 20-million-markkas worth--is scheduled for next year. This transaction is the largest single contract for cable equipment with China so far. Several European, American and Japanese producers of cable equipment also submitted bids. Nokia earlier sold plastic-insulation lines for telephone cables to China for around 10 million markkas. Three years of preparatory work have now resulted in a real opening of the Chinese market. [Text] [Helsinki FORUM FOR EKONOMI OCH TEKNIK in Swedish 6 Feb 85 p 4] 9992

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